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AUTHOR Bartholomew, Robert P.; And Others
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ABSTRACT

Provided is the revised and updated version of a report on the effects of physical environment on the learning behavior of 13 institutionalized moderately and severely retarded individuals (14 to 18 years old). An introductory section covers the need for research in enviornmental control, study objectives and procedures, methodology, and hypotheses tested. Examined in a review of the literature are such aspects of architectural design as furniture, space, color, and light; and covered are details of lighting and behavior studies not included in the original report. A section on methods and procedures covers information on the Ss, apparatus, lighting, color, space density, procedure (which entailed the manipulation of four environmental conditions), and the recording of two types of behavior (on-task behavior and ambient-task movements). Among the effects reported from manipulating color, space, lighting, and space-color were that ambient behavior associated with hyperactivity was not increased by color change and that space reduction resulted in increased on-task behavior. The results of a questionnaire survey involving interior designers, architects, and special educators are also provided in the form of guidelines for designing an appropriate physical environment. Also included are numerous references, tables, and diagrams. (IM)

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AN INVESTIGATION OF THE PHYSICAL ENVIRONMENT & ITS EFFECT ON MR YOUTH

REVISED 1977

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EC 100 450

AN INVESTIGATION OF THE PHYSICAL ENVIRONMENT & ITS EFFECT ON MR YOUTH

Authors:
Robert P. Bartholomew
Sidney R. Miller
Mark Hill

Graphic Design:
Elissa Pellegrino

Data Collection:
Kathleen Murphy
Nancy Myers
Daria Sislow

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INTRODUCTION 1

"Environments have a great effect upon the behavior of the individual because they determine whether or not the behavior can be maintained" (Cohen, 1968). Yet, little has been done to determine the effects of physical environment on the learning behavior of the moderately and severely mentally retarded. The focus of this study described in the following report involved the interior architectural variables ov the classroom, as it relates to learning of adolescent mentally retarded individuals. The essential focus of this report and the research that preceded it was to determine the significance of specific environmental variables--space, color, and lighting--on the overt behavior of adolescents who had been identified as mentally retarded youth.

This research study was an interdisciplinary effort involving contributions from Design authorities and Special Educators, and featuring collaboration between a northern Illinois residential institution and the Departments of Art and Special Education at Northern Illinois University.

Research Need

There is conflicting research in environment control. This conflict is raging among educators and designers, and despite the despute, at this time, appears no closer to resolve than it did nearly 30 years ago when Strauss and Lehtinen (1948) recommended that stimulation in progress for the mentally handicapped and brain-damaged be reduced. Most special educators have accepted the admonitions of Strauss and Lehtinen and have based their research and their efforts on this recommendation. Cruickshank, Bentsen, Ratzeburg, and Tannahauser (1961) found placing students in carols resulted in increased learning. Abeson and Blacklow (1971) indicated no clear direction had been established, though they recommended further exploration was necessary.

Architects believe, intuitively or experientally, that the physical environment does have a behavioral impact (Spring, 1972). Designers of Special education environments have insufficient data concerning the physical environment of the mentally retarded individual's classroom as it influences learning. It has been one of the hypothesis of this project that such information for the designer would result in more informed design decisions, and consequently more educationally effective environments.

Objectives

The five objectives of this study were as follows:

A. To evaluate color, light, and space effects on the learning of mentally retarded youth.
B. To develop an evaluation methodology for environmentaly assessment.
C. To establish performance criteria for architects and designers in determining the appropriate physical education environments for mentally retarded youth.
D. To provide a model and to develop procedure for interdisciplinary projects related to mentally retarded youth.
E. To determine the attitudes and findings of other professionals in the area of environ-

mental controls and contingencies.

Procedure

The operational procedures in this study were two-fold: first, establish a procedure for assessing the effects of the research conducted at the northern Illinois residnetial center. This procedure included determining baseline, pre- and post- effects of color, light and space. This effect was determined using a time-frequency procedure in which graduate students from Northern Illinois Department of Special Education observed and counted specific behavior identified prior to the institution of this research effort. The data derived was collected and tabulated so objective assessment could be achieved. Second, questionnaires were designed to be used to survey professional architects and designers on findings they have reached as a result of their efforts.

Data Collection Methodology

The data collection methodology of this two-fold study was achieved by, first, having graduate students count selected observable behavior during the on-site manipulation of environmental variables. The students observed the behavior of the subjects each Monday and Friday during the four month duration of the study. Following the observations and tabulations, the data was translated onto computer data cards which were later used in statistical analysis, using a SPSS program. Second, by sending out questions to selected authorities in the field of educational architecture and design, the investigators were able to accumulate data on the state-of-the-art in environmental design. Other data related to the questionnaire was collected through interviews and literature reviews. All data was coded and converted to data cards, which were later analyzed.

The primary considerations in the study is whether the acceptance of certain "givens" in design, i.e., "hot" colors being stimulating or that greater density causes hyperactivity are valid. As indicated in the literature search, some researchers have demonstrated a correlation between these environmental factors and human behavior. Special educators vary in their opinions concerning the desirability of a stimulus in the environment. Some believe stimulating factors contribute to hyperactivities while others believe stimulation is what the student requires. It is then essential that this conflict be resolved through careful environment research, in which researchers manipulate the variables and then carefully measure the effects. Questionnaire responses, by educators and designers throughout the nation demonstrates the lack of uniformity of opinion and design in education.

The investigation was undertaken to test specific hypotheses which include:

a) That "hot or warm" colors will cause more movement and visible activity will be more stimulating than "cold or cool" colors, particularly

colors that are commonly used in schools or institutions (i.e., Institutional Green). It was recognized by many that "hot" colors may encourage less on-task behavior.

b) That an increase in space density, that is the same people and equipment in less space that previously occupied a larger space, -- resulting in closer visual, aural and tactile contact--will cause greater visible activity, aggression and less concentration on tasks.

c) That introducing incandescent wall-washing fixtures into the environment will create a more attractive varied environment and cause greater movement and stimulation. Such lighting will have to take into account task lighting requirements.

The incandescent light source provides sparkle interest, control and a definite bias toward emphasizing "warm" colors. It is, however, an inefficient light source with high maintenanance costs and it produces excessive heat. The incandescent source is good for creating pools of light or a controlled luminous area.

The lighting level change occurs most noticeably (see diagram no. 1) along the room perimeter

Insert Figure 1 about here

which is in the field of vision but it has little effect on the task lighting condition as the

residents' desks or work areas.

The florescent lighting condition is typical of many educational settings and it is designed for efficient economical operation with relatively low maintenance in providing adequate footcandle levels for task situations. It is a dull monotonous type of lighting with little stimulation or sparkle. Frequently, the color rendition is distorted or biased.

The basic question is whether mentally retarded youth work in on-task activities better in a monotonous or stimulating setting and if so, should the teacher have the option of controlling it? This question is in line with the practice of behavioral modification which is fairly common in mentally retarded residential institutions.

It is recognized that the use of the track fixtures introduced two other variables: increased footcandle levels and increased heat levels. The studies were conducted at a time of year when the room is heated and controlled by a thermostat. Temperature differences in the room comparing the days when lighting system was used and not used shows negligible difference.

Insert Figure 2 about here

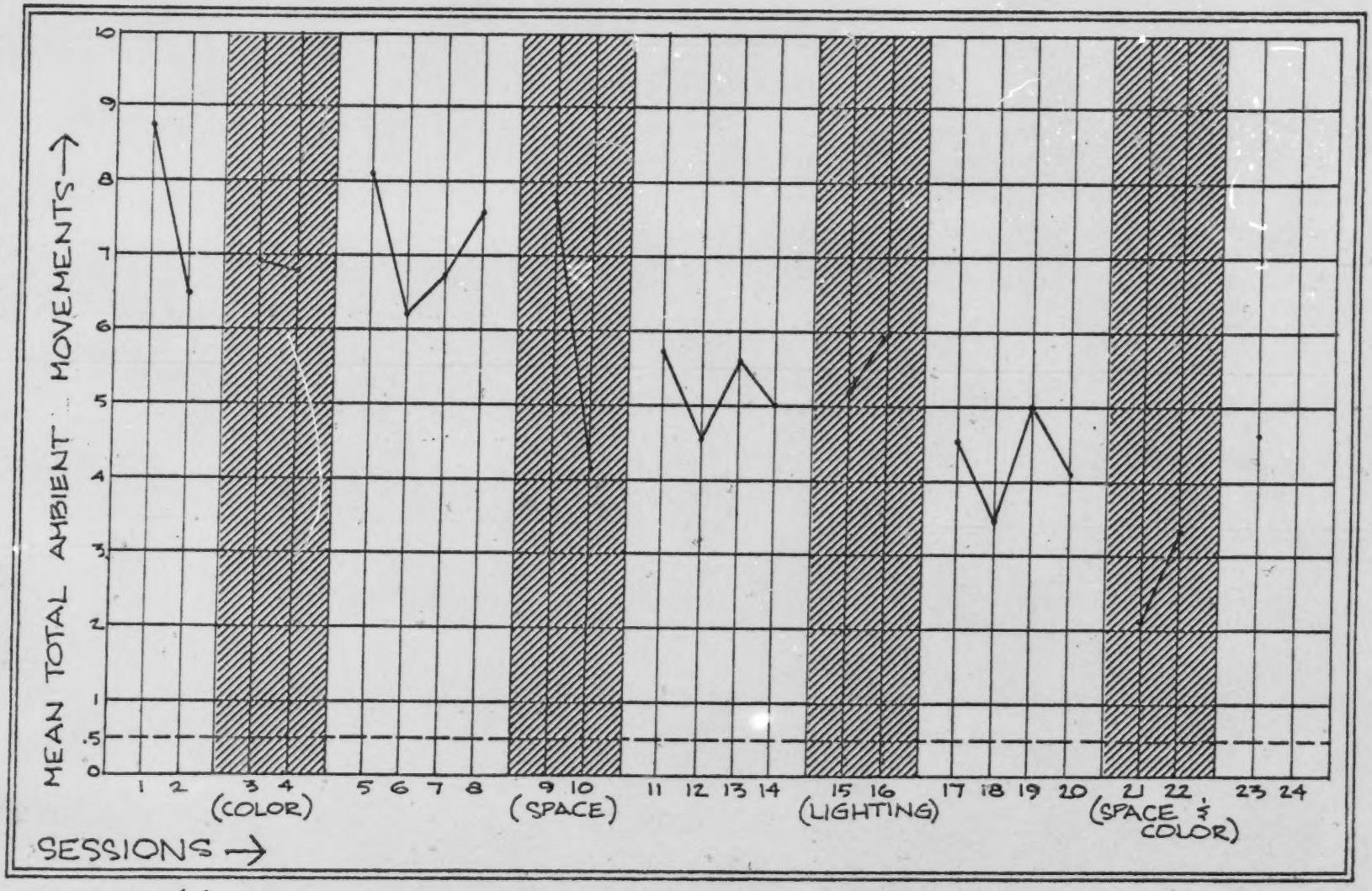
In changing the space horizontally, it is recognized that the spatial proportions are also changed that is the width to the heighth relationship. The study is asking the question whether a stimulating

KEY

COLOR - RED PANELS UP
SPACE - CURTAIN UP
LIGHTING - TRACK FIXTURES IN USE

FIGURE 1

MEAN TOTAL AMBIENT MOVEMENTS
13 SUBJECTS

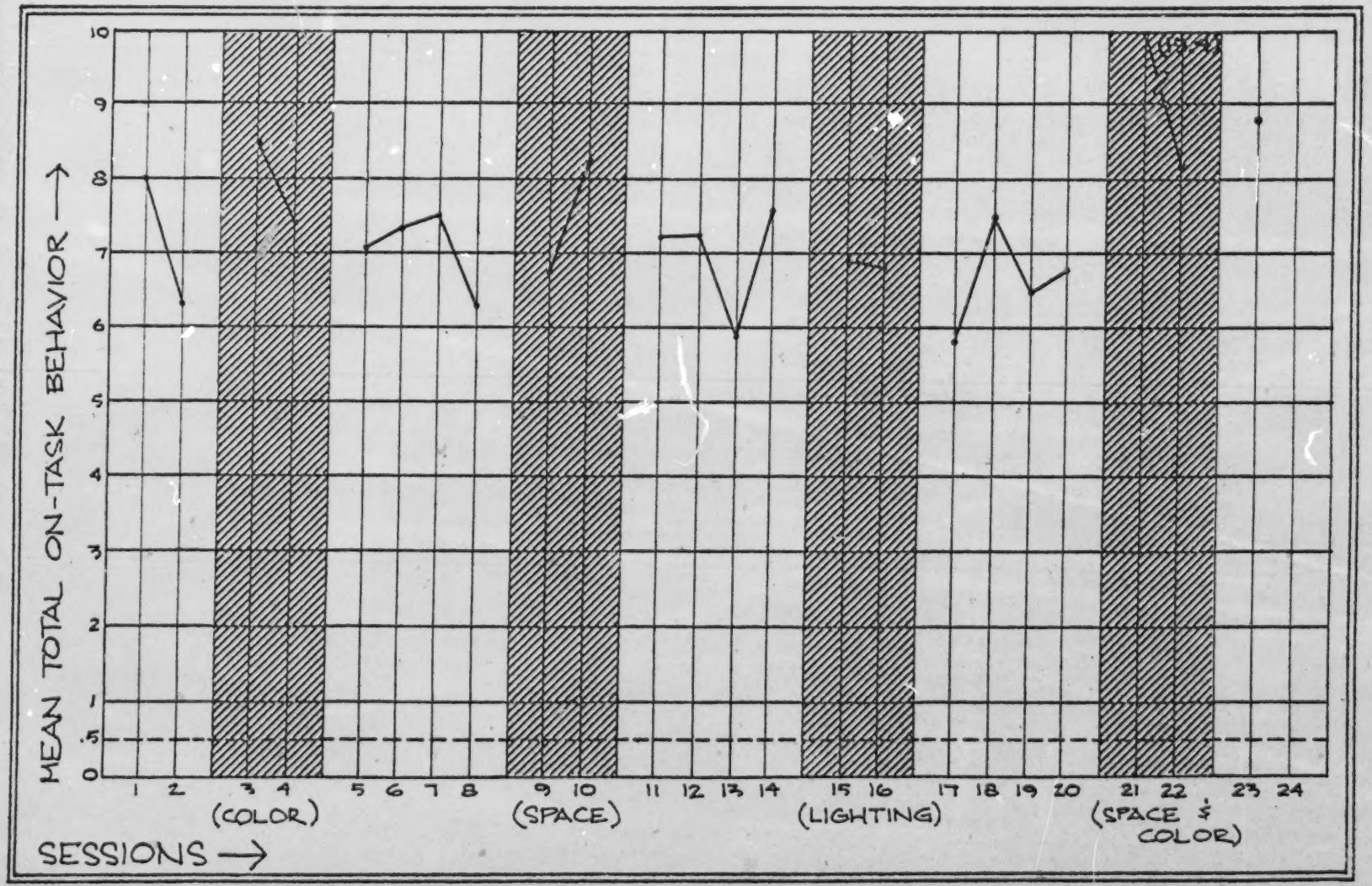


KEY

COLOR - RED PANELS UP
SPACE - CURTAIN UP
LIGHTING - TRACK FIXTURES IN USE

FIGURE 2

MEAN ON-TASK BEHAVIOR
13 SUBJECTS



or monotonous setting will distract or aid as a reinforcement in learning whether it can become a tool for the teacher to use as an aid in learning. Can a more lively environment aid in the mentally retarded residents enjoying and utilizing the environment better or would a more monotonous environment encourage greater concentration?

One of the considerations in the study is either the acceptance of certain given; in design such as hot colors are stimulating or that greater density causes hyperactivity. As indicated in the literature search, some researchers have shown that there is definitely a correlation between these environmental factors and behavior. Special educators vary in their opinions in seeing the desirability of a non-stimulating environment to control hyperactivity and those that consider a "normal" environment preferable. This is done to acclimate the mentally retarded youth to enter the "real" world.

Organization

This report is organized into five chapters. Chapter I will provide the overview; Chapter II will contain the literature review; Chapter III contains the overall procedures used in operating the research efforts and analyzing the data; in Chapter IV, the reporting on the data will be exhibited; and Chapter V will summarize the findings and recommend further efforts and directions.

It is suggested by Nellist (1970) and Thuse (1973) that buildings and rooms can be disigned and furnished to make a positive contribution to the well-being, education, and development of mentally retarded and emotionally distrubed children.

The built environment can be viewed as a physical and social setting that has the potential of contribution to individual or group objectives (Sommers, 1969) or a support system comparable to the natural environment which supports human activity or welfare (Hall, 1969). Robert White, a psychologist believes that a person's sense of competence can be affected by ones interaction with others and the physical environment (Armstrong, 1962).

While the physical environment may frequently be unobstrusive, there are occasions where the intensity of environmental stimulation may be such as to cause a malfunction of the current behavior (Spivak, 1967).

In general, warm, luminous colors can be expected to produce an active, cheerful feeling. Red and related colors tend to activate. Blues, violets and greens tend to calm. Light colors activate, and deep colors produce passive moods (Birren, 1961). Birren also suggests if warm color tends to be moderately exciting and if a cool color tends to be relaxing, this is justification enough to use color in certain ways rather than haphazardly.

Yet, the physical environment has been ranked as one of the most critical facility deficiencies (Braddock, 1975). Walfensberger documents the failure of a large number of institutions to meet their aims. Architectural planning is seen as an issue requiring special attention as short range specific goals for the future (Stringham, 1966) and the architect's role in planning for the retarded is seen as having increasing importance (Bayes, 1972).

Sokoloff (1967) calls for the re-examination of many basic assumptions made by those involved in designing facilities that deliver services to handicapped persons.

Gunzburg (1972) charges architecture with the responsibility of encouraging sensory stimulation in the subnormal child. However, little has been done

to give architects and designers specific information on which to solidly base design decisions. Collection of such data is making progress, but research to date gives little attention to the influence of environment on learning (Baas, 1972). Part of this is due to the complexity of the issue.

Kenneth Bayes (1967) clarifies the need for research on the effects of architectural form and color in the treatment of mentally retarded youth. He takes an interdisciplinary approach to research, as architects, psychiatrists, psychologists, educators, anthropologists and sociologists in Great Britain, Europe and the U.S. were consulted to findings, opinions and practices.

H. C. Gunzburg (1973) mentions the importance of the contribution of other disciplines in considering rehabilitation, also, as does Jordan (1968). The need for research and exchange between disciplines is treated as an important topic for consideration on the problem of the mentally retarded.

It has been suggested that program planning be included in architectural discussions to avoid later modifications (Blair & Leland, 1967). The advisability of involving staff in planning and acquainting the architect with special needs has been noted (Elliot & Bayes, 1972). However, certain management concepts and traditions were found to adversely influence the physical environment, limiting its scope (Gunzburg & Gunzburg, 1973). One of the difficulties in designing for the mentally handicapped is, like most people unaffected by such a handicap, to overcome an ignorance of the nature and problems (Seminar Design for Hnaidcapped, 1975).

One author (Rohles, 1971) suggests that the poor student will always be a poor student in spite of all the contribances we may use or environmental controls that are developed. But he also states that it is conceivable that the preferred environment may be the single feature of the learning situation that transforms the marginal achiever into the ranks of the satisfactory student.

One author calls for buildings that are not "abuse resistant," with features such as wire glass, bars over the windows and similar overprotection of the handicapped (Wolfenberger, 1972). However, many institutions find that the cost of damage to walls, furniture and other interior furnishings to be extensive and are forced into a defensive position in their selection of interior components. Typical recommendations include:

"Furniture pieces should be of heavy, solid material, so that residents may not lift, throw, or break them.

No free forms or unsupported curves should be on furniture, because these are easy breaking points.

All joints should be laminated and reinforced, so that bending or breaking will not occur if abused.

Furniture should be able to take the abuse of harsh detergents and hot water without losing their attractiveness or protective finishes.

All screws and bolts should be recessed into the furniture piece to prevent residents from removing them.

Cushions should not bu utilized, because they can be easily torn and destroued making their cottage life expectancy short.

Furniture should be seamless to that dirt and urine can not build up in the seams making cleaning difficult and causing unsanitary conditions.

Surfaces should be easily cleaned using hot water and harsh detergents. Disease and viral transmission may be difficult to control if maximum sanitation is not provided. Strong, harsh detergents are necessary for sanitation.

Though cushions should not be used, if it is necessary, they should be covered in a hard vinyl which will aid in preventing seepage into the foam and also be easy to scrub.

No small screws or bolts or glides should be used which could harm residents by self inflicting wound, swallowing, or using as a weapon.

Storage and supply cabinets should be equipped with locks to prevent access by residents.

Furniture that is modular may be chosen because of its ability to adapt to different shapes and environments as may be necessary if more furniture were needed in other areas of the school, and its ability to be placed in various arrangements creating changing looks to the same space.

Shelves and storage cabinets should contain moveable shelves so that they can be changed to different levels as the stored items change.

Stacking chairs or tables are useful, because when they are not needed they can be stacked and stored in minimal space. (Bartholomew, 1976)"

Space

There are numerous guidelines published for space and equipment requirements. In regard to classroom organization, it is recommended that space be used to keep children involved and interested, not only with equipment but with each other, so that social development can be supported. (Kritchevsky and Prescott, 1968). Space communicates with people, telling them how to act and how not to act relative to what is in the space and how these things are arranged or organized. Kritchevsky and Prescott, (1968) also point out how efficient use of space helps teacher supervision and aids in access to needed materials.

Many reports exist which include planning guidelines for facilities to house the mentally retarded. The bulk of information concerning the planning of facilities for the mentally retarded is directed specifically toward the residential living units. There is general agreement throughout the literature that a home-like atmosphere is most beneficial to the mentally retarded and that the closest approximationg to family living produces the best results toward normalization (Leo Cain, 1961; Joseph Wingold, 1973; Craig, 1971; Simpson, 1973).

Larry Mollow (1974) suggests getting away from restrictive, separate environments and toward the least restrictive environment, toward facilities more like those provided for normal children. Implications are for the "cascade" system, or a continuous series of less restrictive alternatives, gradually transferring back toward the everyday classroom.

Kreger (1971) found that by altering utilization of living space to reduce congestion and by increasing the availability of varieties of sensory stimulation there resulted a reduction in environmental stress. The results of an experimental program indicated that manipulation of living conditions is one of the most effective approaches to changing the behavior of severely disturbed subjects. It has been found that brain-damaged children increase in aggressive behavior (fighting, snatching or breaking toys) as group density increases.

Hutt and Vaizey (1966) studied autistic, brain-damaged and normal children between the ages of 3 to 8. The children were observed in a samll group with regard to aggressive behavior (fighting, snatching, or breaking toys) social interactions and time spent on the outer boundaries of the room as a function of different "social densities," or number of children within the same spatial area. For groups ranging in size from 6 to 12, the data indicated that brain-damaged children increased in aggression as group density increased, while normal subjects became more aggressive only in smaller groups. For social encounter, normals showed a decrease in interaction in larger groups; brain-damaged children showed more interaction in medium size groups; autistic showed less interaction in large groups. Furthermore, as density increases, the autistic children spent significantly more time at the boundary of the room, although the effect held generally for all populations.

Changes in intellectual, emotional and social functioning are seen to stem from favorable environmental influences. A normal environment encourages the development of normal, relatively independent living and a domestic atmosphere and is the most suitable for socialization and educational programs (Gunzburg & Gunzburg, 1973).

There is strong agreement among sociologists and architects involved to get away from the conventional institution-like setting (R. Blakeley, 1972).

Grunewald (1971) suggests that influence for favorable development is to be found partly in the small number of interpersonal relations forced upon the retarded, thus making them potentially stimulating rather than frustrating.

British Journal of Mental Subnormality, V17 N32 P54-65, June 1971, describes a project to redesign a hospital ward for the mentally retarded which was the result of an interdisciplinary approach, where the residents were found to benefit from new living conditions which approximated a more home-like arrangement and encourage a family style of living.

In discussing suggestions for improvement of living arrangements, it is emphasized tha hominess and dignity in residential units for small groups is beneficial (Elliott & Bayes, 1972).

Ontario Department of Education, Toronto (1968) suggests three types of environmental design, for mentally retarded, severe, moderate and mild. Severe require the most rigid design, with clearly defined separation of spaces, moderately have less rigid design and mild have fewer enclosed spaces.

With respect to the classroom situation, literature would seem to suggest as normal an environment as possible with encouragement of activities extracted from daily life to be the most veneficial for the mentally retarded (H. C. Gunzburg, 1972; International League of Societies for the Mentally Handicapped, 1972). The need for an interior design program to include home-like surroundings and promotion of greater sensory-perceptual experiences has been stressed (Hobbins, 1972).

One study (Rohe and Patterson, Effects of Varied Levels of Resources, 1974) with normal children in a day care center indicates that there is a correlation between density increase and negative behavior such as aggression or destruction. Density also had an effect on the use of the play areas. There was significant increase in cooperative behavior, relevant participation and constructive behavior in high resource conditions and a concommittant decrease in irrelevant participation. The study suggests that in situaltions where cooperative behavior is important, an increase in density with a concommirant increase in play materials is suggested. Or another way to see it, a large quantity of resources will help ameliorate the negative aspects of crowding.

Dr. Osmond (1965) suggests that in considering the psychological dimensions of architectural space it is best to avoid anything which makes heavy demonads on the patients impaired perceptual apparatus. One should avoid ambiguous and muddled design, too much space, and too many people. Insure that shapes, color, lighting, textures are unambiguous and that corridors and spaces are clearly delineated. He defines building as either socio-petal, that are designed to draw people together or socio-fugal, which is to discourage social relationships.

R. Scheerenberger (1972) notes the importance of respect for human rights and dignity in considering effects on physical environment on behavior. In examining numerous centers, it was found that flexibility in the construction of the physical plant, including non-permanent walls and fixtures, was necessary (Blair and Leland, 1967).

There is wide agreement of the notion that ambiguous or muddles spaces, undefined corridors and too much space should be avoided (Osmond, 1965). Recommendations on sizes of spaces according to one research report (Environmental Criteria, Mentally Retarded Preschool Day Care Facilities, 1972) should be determined by the nature of the activity(s) which will take place in the areas, the number of children and adults involved, and the furniture, equipment and supplies used. Also mentioned is the importance of the objects in a space being scaled to the childrens' size.

Features such as open plan and barrier-free design have been cited in facilities that have incorporated specific designs for children with various handicaps, including mental retardation (Mollow, 1975). A responsive environment was found to be no more effective for learning than a nonresponsive environment, but the responsive environment was more efficient in that the same amount of material was learned in less time (Brown, 1971).

Color

Ample theories and documentation exist on the effects of color on normal subjects. Overwhelming agreement can be found throughout the literature to support similar results.

A recent seminar presentation (University of Wisconsin, 1975) by Dr. Harmon would suggest that color does have the potential of considerable perceptual effect on the viewer. This is particularly true in regard to spatial condition. As Dr. Harmon points out since red comes to a point behind the retina, we must in effect pull the red level forward to bring it into focus. Conversely, the blue converges in front of the retina; we must in effect pull it back in order to see the details of the patterns and colors we want to see. The shift of focus changes the apparent position of the background color. If the background color is blue, it seems to move away from the viewer; conversely, if the background color is red, it seems to move toward the viewer. This is assuming a situation where color contrast exists under while light.

Colors appear to have a biological cue function implicit in the physical characteristics of color which affects the viewer's sensory mechanisms Schaie, 1966).

Birren also says, " It may thus be generalized that color affects muscular

ntension, cortical activation (brain waves), heart rate, respiration and other functions of the autonomic nervous system and certainly that it arouses definite emotional and aesthetic reactions, likes and dislikes, pleasant and unpleasant associations.

With high levels of illumination, warm and luminous colors in the surroundings (yellow, peach, pink), the body tends to direct its attention outward. There is increased activation in general Alertness and outward orientation. Such an environment is conducive to muscular effort, action and cheerful spirit. It is a good setting for factories, schools, homes where manual tasks are performed or where sports are engaged in. Second, on the other hand, color and light also tend to have a cetripetal action--away from the environment and toward the organism. With softer surroundings, cooler hues, (blue, green, turquoise) and lower brightness, there is less distraction and a person is better able to concentrate on difficult visu[illegible] and mental tasks. Good inward orientation is [illegible]hered. Here is an appropriate setting for s[illegible]ary occupations requiring severe use of the [illegible] or brain--offices, study rooms, and fine assembly in industry.(Birren, Illuminating Engineering, 1969,p. 4).

One authority observed that colors have decisive influence on the child's mental performance. Popular colors were found to stimulate alertness and creativity in normal children while white, black, and brown made the children duller (Time, September 1973).

Corah (1967) in a study on color-form matching in young children found that differences in hue had no significant effect on color matching while differences in brightness produced the greatest number of color matches. It was suggested that contrast effects may be important in centering the young child's attention on color, often to the exclusion of form.

Cheskin (1947) reported children age 1 to 6 are attracted to the pure hues. The young child prefers red. "Normal children like red best and blue least." This information conflicts with Navrat but coincides with Frieling.

Gramza and Witt (1969) conducted a study with 35 nursery school children 4-5 years of age, where they were observed while they were allowed to play with blocks red, blue, green, and gray presented in varied spatial array. Position preferences were more important than color preference in use of blocks. The study emphasized the prominent role of stimulus contest in play behavior. Other color preference studies have been done out of context of objects and with relatively passive samples. It is impossible to tell how they would react to color in a naturalistic setting. This study investigated the role of color in one spontaneous behavior: play. The experimenter wanted to ascertain role of color relative to other stimulus variables operative in block play.

The findings indicate that color is not of general preference in block play. Position preference

did appear to be the single most important factor. Samples clearly preferred block piles at either end of semicircle array despite changing colors.

Navrat (1965) in testing 160 children found primary colors, in order of preference, to be blue, red, green. and yellow.

Infants three months of age prefer color over gray and up to 24 months of age prefer red. Beyond this age, there is a decreasing group preference for any particular color. In Frieling's (1961) study with children from ages five to nine tested at two-year intervals, it was found that likes and dislikes were more extreme for the younger children. The youngest liked red and magenta and the 5-10 year span had a violent dislike for black. An enthusiasm for full chromas was noted, strong pure color and at all ages of childhood a dislike of neutral colors whether in dark or light range.

A study was recently conducted with children (Allen and Dilbeck, Unpb.) using red and green alternating as color variables in an interior setting. The investigation concluded that the results raised serious questions as to whether color was a strong factor affecting behavior.

However, one director has found that both children and staff have responded well to a colorfully designed environment (Carling, 1968). Scheerenberger (1972) feels that the retarded child responds well to a lively, colorfully stimulating environment.

Color cannot only contribute to the beauty of a center, it also produces a psychological effect on the behavior of children. Where carefully planned color schemes appear to influence the scholastic achievement of elementary school children (Environmental Criteria, Mentally Retarded Preschool Day Care Facility, 1972).

Behavior seems to be increased or relaxed according to the type of color stimulation. Red and related colors activate; blues, violets and green calm. Light colors activate; deep colors produce passive moods. There is some reason to believe that with maladjusted children, excitable individuals respond more therapeutically to stimulating colors and withdrawn children to cool colors. Children respond best to colors which are in sympathy with their own emotional condition. Bright colors were shown to attract the staff to the area treated with them, to increase staff morale, and to heighten the activities of the children. There was no evidence that bright colors had an adverse effect

on any of the children (Sandhu, Hendricks-Jansen, 1974).

Bayes (1967) has summarized some of the work related to mentally retarded children and color as follows: Goldstein's work was with brain-damaged patients and he found that warm and cool colors, particularly red and green, exert a different influence. Under red, speed of movement was greater as also were loss of equilibrium and perceptual distortions in judgements of size, weight, and cutaneous localization. Green tended to minimize abnormal conditions. Nakshian studies with normal individuals, only partially supported these conclusions, but it is possible that the brain-damaged are more susceptible to color than normal subjects. From the physiological aspect Gerard's results showed that red produced more and blue less activity than normal. For instance, red produced an increase in blood pressure, in respiration and in frequency of eyeblinks whereas blue produced a decrease. Red produced tension, excitement, a feeling of warmth, reduced ideation reduced with uneasy tension and defensive drowsiness-suggesting that color shock is more likely under red stimuli (passion, sexual attraction). Blue resulted in a feeling of well-being, calmness, pleasant thought, coolness, tenderness, less anxiety or hostility, less awareness or concern of outside noise. Under white light the subjects felt bored and disinterested, even though physiologically it was stimulating.

Bayes summary includes the description of an experiment with maladjusted children by providing interchangeable desk tops of four different colors and allowing the children to choose which they would like to use and to change them during the course of the day as they felt inclined. The red tops were the most popular early in the morning and during the beginning of the week, but during the latter part of the day and of the week the yellow, blue, and green were chosen. Green and yellow were most in demand for creative lessons; the red tops stimulated most activity in the way of scribbling and carving. Red may be suited to produce the emotional background out of which ideas and action will emerge; in green these ideas will be developed and the actions executed.

In Bayes is also presented suggestions by Pietzner, Whihs, Rudel and others suggest that with maladjusted children the excitable ones respond best to stimulating colors and withdrawn children are helped by cool ones. The design of lighting is indivisible from color. Variety and contrast in lighting intensity (as in color) are stimulating, if excessive they can lead to discomfort and glare.

Hobbins (1972) suggests the use of colors chosen to enhance the 3-D qualities of forms, thereby helping children with perceptual difficulties. Though another study indicated that color preference was not of primary importance in the block play of the normal children tested (Gramza and Witt, 1969).

Another fact is that no two handicapped children will probably respond in precisely the same way to a certain color (Sanhu, Hendriks-Jansen, 1974).

Light

Light, or the effect of light (color, form, perception) becomes signals or environmental inputs to the perceiver. Vision is the primary means of environmental perception for most people for both foreground and background purposes. The extreme of sensory deprivation is suggested (Myklebust, 1964) as causing alteration of the psychological response mechanism.

Lighting research in the past has dealt primarily with optical concerns, focusing on such considerations as brightness, contrast, glare and reflectance. In general, studies conclude that accuracy and speed of seeing, contrast sensitivity, visual acuity, and the physiological functioning of the eye continue to improve significantly as the lighting level is increased to an optimum point (Guth and White, 1965).

There is considerable research that has been concerned with physiological responses of a person to light in a physical environment. Some work has been done to try to understand man's psychological reactions to light but it is an area that has received relatively little attention. Clearly more research is needed about the psychological processes which affect behavior due to lighting.

The psychological response to lighting depends upon how the visual system assimilates, processes, and responds to the environment. Perception of object brightness is also a function of environmental illumination. Guth and McNeils (1969) also studied subjective differences related to visual performance.

Laszlo (1969) reported that some reptiles refused food to the point of starvation while under a cool while light source; but their eating havits returned to normal when they were put under the sun-

light lamp. Researchers at M.I.T. (Wurtman and Weisel, 1969) placed 150 rats under equal exposures to the sunlight lamp and the cool-white lamp, and found statistically significant differences in the weight of their organs. Other research efforts at the University of the Pacific, the Veteran's Administration in Boston and Tufts University (Sharon, Feller, and Burney, 1971) have demonstrated remarkable differences in the light-related incidence of dental cavities and gonadal development in rats, those raised under the sunlight lamp having fewer cavities and larger organs. In contrast to effects under the sunlight lamp, animals raised under conventional blue light have exhibited growth retardation (Ballowtiz, Heller, Natzschka, and Ott, 1970). Although Sausville (1971) was unable to replicate these findings, Fiske (1970) found definite light related growth effects in rats. Neer, Davis, Walcott, Koski, Schepis, Taylor, Thorington, and Wurtman (1971) and Neer, Davis, and Thorington (1970) demonstrated that one month's exposure to the artifical sunlight environment increased the calcium absorption of healthy adult males over those who were under the cool-white conditions. Similarly, it was shown that plants which were previously unresponsive to standard artificial light grew successfully under the artificial sunlight lamp (Kalmbacher, 1970; Sard, 1969), and appreciable bactericidal effectiveness accompanied the use of the artificial sunlight illuminant (Himmelfarb, Scott, and Thayer, 1970).

Florescent sunlight lamps were compared to standard florescent lamps in a study of the long-term effects upon Russian school children in Zamkova and Krivitskaya (1965). They found more favorable effects upon the health and physical development of the children under the artificial sunlight source. The pupils exposed to the sunlight lamps had a shorter reaction time to light and sound, were less easily fatigued, and showed an improved working capacity. The improvement of their academic standing was felt to be related to the favorable physical helth factors.

In an investigation to determine the relative merits of natural daylight and artificial light Hammel and Johnson (1956) examined schools with lighting systems utilizing natural daylight and artificial light in a variety of designs: glass block, plastic domes, clerestories, overhangs, and windows. They concluded that artificial light, properly utilized, is less expensive, more uniform and comfortable, and more adaptable to modern teaching techniques than daylight. Manning (1967) summarized the problems associated with the current practice of working from a largely intuitive understanding rather than basing design decisions on empirical research, and stressed the need for understanding (1) the purpose and (2) the subjective qualities of school environments.

Conflicting views exist as to the effect that lighting can have on a learning situation. D. B. Harmon's work (1949) has shown that light can be useful for directing a child's attention to task and restricted visual environments are effective in initiating purposeful performance. Light

was also found to be a powerful reinforcer.

Ott (1968) reviewed research in radiation and its effect on animal and plant behavior. The review indicated that the increased use of lighting and television has a profound influence on the growth, development, and habits of humans and animals. The author notes children develop abnormal behavior after watching television for sustained lengths of time, and it was suggested that individuals: 1) view television less, 2) sit at least 15 feet away from the television set, and 3) use shield on lights to reduce their radiation emission.

An article (Joan Arehart-Treichel, 1974) focused on the belief that natural sunlight can have an effect upon health and behavior. Hyperactivity in children is an example with many children receiving drugs for this problem to calm them down. In the article, John Ott, president of Health and Light Research, Inc. in Sarasota, Fla. states that environmental lighting and background radiation may be responsible. A study was described in the article where two classrooms continued to be lit by standard cool white flourescent lights that lacked the ultraviolet waves common in sunlight. Other lamps were then substituted duplicating natural light. According to the children's teachers, the hyperactive children did improve their behavior under the new lighting so that drugs were no longer needed. It is suggested that flourescent lights have a connection with hyperactivity. This report also mentioned Ott's discovery that radio waves leaking from cool white flourescent lights might contribute to hyperactivity in children.

Both color and lighting have been cited as distractions with a need for control in the physical environment of training centers for the mentally retarded (Bryant, 1964).

Recommendations include a uniform lighting system. However, an enriched environment for the emotionally disturbed, according to Mollow (1975) would feature well-defined activity centers in addition to varied lighting and equipment. Glare, light distribution and source brightness play an important part in this environment. The production of a glare-free visual environment where the brightness-balance is appropriate to the activity performed can be critical in alleviating task-related visual difficulties.

Lighting systems which have diffusing or refracting material below the lamps (semi-direct or luminous ceilings) are the best florescent lighting systems. The biggest problem with florescent lighting with handicapped children was found to be the absence of shadows which tend to make the surrounding environment flat and and uninteresting. On the other hand, sharp, contrasting shadows would provide the handicapped child with more clues and information about his 3-dimensional surroundings. The only reason florescent lighting is specified is because there is no alternative system providing high luminance values for the same running costs.
It is felt that certain areas warrant the use of

some incandescent light in combination with a background of flourescent tubes in gaining spatial clarity delineation. This may also aid color rendition or balanced with a combination of "warm" and "cool" light sources.

Some designers intentionally use light and dark patterns to distinguish between functional areas (Flynn, 1972). The investigator also points out how light patterns can reinforce moods, increase person to person interaction and emphasize or deemphasize specific environmental features.

LIGHTING BEHAVIOR PROJECT REVIEW

Of particular interest may be two related lighting behavior studies. These have been added at the end of this report.

Method

Subjects

A pre-workshop classroom in a Northern Illinois State residential facility was chosen as the experimental environment. The selection of a classroom within an institutionalized environment allowed for a reduction in confounding variables in that (a) in a 24 hour residential setting subjects, out-of-class activities and environment are of a more homogeneous nature than children in a public school setting, and (b) the residential school classroom typically undergoes fewer physical environmental changes than does a public school classroom. Thus, a classroom set within an institutionalized environment would provide a mileau where more homogeneity exists in the environmental experiences of students and may more readily illustrate the effects of environmental experiences of students and may more readily illustrate the effects of environment design change than classrooms which undergo rapid/ regular environmental change.

The instruction within the cooperating classroom consisted largely of basic prevocational counting and sorting skill training. The facility selected was Dixon Developmental Center, Dixon, Illinois, of which the major client population is severely and profoundly mentally retarded (1800 residents). The facility is located on the edge of a rural town, shops, restaurants, and merchants are beyong the walking distance of the residents.

Thirteen (13) subjects (6 females and 7 males) were selected as the experimental population on the basis of the following criteria: the absence of oculomotor defect, hearing impairment, or other detectable sensory dysfunction was a criterion for selection of subjects. The subject's age could not exceed 18 years nor be less than 14 years old and, the IQ of each subject, based on an individualized intelligence test administered within one year of the onset of experimental conditions, could be no less than 35 nor more than 70.

The mean age of the 13 selected subjects was 16.07 years and IQ scores ranged from 39 to 60 with a mean IQ of 49. The total length of institutionalization of all subjects ranged from 1 year to 12 years with an average of 4.84 years. In addition, the total amount of time spent in the classroom and other instructional activities on a weekly basis was also claculated for each selected subject. On this factor, a range of 42 hours to 18 hours per week was found with a mena of 27.8 hours for this group of residents. The factor of parental involvement (i.e., the frequency of parent-visits and home-visits) was also examined and was found to vary greatly among subjects, ranging from no involvement to frequent parent and home visits. Discrete subject demographic information may be examined in Table 1.

Insert Table I about here

Subjects were randomly assigned to one of two class periods (8:15 a.m. or 10:00 a.m. class). Four (4)

TABLE 1

SUBJECT DEMOGRAPHIC DATA.

INFREQUENT = 1-2 VISITS PER YR.
OCCASIONAL = 8-12 VISITS PER YR.
FREQUENT = BIMONTHLY OR MORE

SUBJECT ↓	SEX	AGE YR/MO.	IQ	INSTRUMENT	YEARS OF INSTITUTIONALIZATION	HRS. CLASSRM. INSTRUCTIONAL ACTIVITY/WK.	PARENTAL INVOLVEMENT
1	M	17/8	41	S&B	6	29	NONE
2	M	15/2	54	WISC.	2	34	INFREQUENT
3	M	17/8	44	S&B	2	18	FREQUENT
4	F	15/10	45	S&B	2	36	FREQUENT
5	F	16/3	69	P.P.V.T.	2	42	OCCASIONAL
6	M	17/1	60	WAIS	12	42	FREQUENT
7	M	14/3	12	S&B	1	28	OCCASIONAL
8	F	14/8	46	S&B	10	19	NONE
9	M	16/0	36	S&B	9	21	OCCASIONAL
10	M	15/2	60	S&B	2	45	FREQUENT
11	M	14/0	39	S&B	3	18	FREQUENT
12	F	15/5	70	S&B	4	31	OCCASIONAL
13	F	18/0	55	WAIS	2	22	FREQUENT

females and 3 males attended the early class, while 2 females and 4 males attended the second class period. The subjects were not informed as to the reasons for environmental manipulations or the time when any environmental change would take place within the classroom.

Apparatus

Observations of subject's behavior by four Special Education graduate students was facilitated by codings made during 10-second intervals. A cassette tape recorder with two ear plug jacks transmitted time interval directions to the observers, who were rotated randomly to prevent judge biasing. The recording entailed start, stop signals for each 10 seconds. The number of the appropriate interval was transmitted to the observers prior to each start signal. The room as first observed by all subjects consisted of a classroom 20' by 30' painted light green, with basic fluorescent lighting, window exposure was along the length of the west wall. Technical information concerning the three environmental conditions is listed under the following headings: Lighting, Color, and Space Density.

Lighting

The two lighting conditions present for baseline conditions were as follows: (1) general illumination from fluorescent pendants provided by mounted two-lamp fixtures spaced at 6-foot on center intervals throughout the space. The lamps consisted of two 40 watt cool white flourescents.

In the lighting condition, in addition to the previous lighting mentioned, track lighting with 12 fixtures using 300 watt reflector footlamps were utilized. The fixture lined the length of two working walls, north and east, and were directed towards the wall, supplying bounce lighting. Dimmer controls permitted various lighting levels in the classroom.

Color

Painted 4' by 8' panels were attached to the north and east walls using furring stripes and a grooved base runner for panel support. Each side of the panel was painted and could be easily turned to create a specific effect (e.g., red room or green room). The pre color condition was a "cold" light green, five (5) G matte finish according to the Munsell Color system. The post color condition was a "hot" red five (5) R matte finish on the Munsell system. The colors were selected according to four criteria:

A. "Hot" and "cold" color opporsites to test the designers reaction to their two polar or complimentary atmospheres.
B. To test the behavioral response to two contrasting situations that might be found in an interior environment (stimulating vs. dull and/or distracting vs. unobtrusive).
C. Selecting of complimentary colors according to the Munsell Color system. Five G and five R matte finish were the colors selected.
D. To select colors that were constant on the

color assessment phase. Cool white fluorescent lighting was provided for all color assessment phases.

Space Density

The space size or square footage at the test site was altered using a 10' canvas screen or curtain suspended from a horizontal rod across the room width west to east to the floor. The canvas was a neutral off-white of a value 3 on a 1-9 value scale. The same objects and furniture were contained in the reduced space as in the normal class setting thus increasing the space density or the crowded conditions of the space. The screen reduced the size of the room from 20' x 30' to 20' x 20' from 500 sq. ft. to 400 sq. ft.

Procedure

The design of this project entailed the manipulation of four (4) environmental design conditions. Each of the 4 conditions is viewed as discrete experimental manipulation in that an A/B/A experimental design was utilized, that is, a baseline was established/the environment was then manipulated/followed by a return to baseline conditions for each of the four experimental conditions.

The same classroom, teacher, and teacher's aide were involved for both groups of subjects, the 8:15 a.m. class and the 10:00 a.m. class. The teacher and her aide were briefed as to what type of environmental variables were to be manipulated and at what date the manipulations were to take place. The students, however, were not informed of the type or the time when environmental changes were to take place.

1	2	3	4	5	6
Lt. Gr.	Red	Lt. Gr.	Reduced Space	Lt. Gr.	Lt. Gr.
Pre	Exp.	Post	Pre	Exp.	Post

7	8	9	10	11	12
Lt. Gr.	Additional Spot Light	Lt. Gr.	Lt. Gr.	Combination Color Change (Red) with Reduced Space Density	Lt. Gr.
Pre	Exp.	Post	Pre	Exp.	Post

The baseline condition of the classroom consisted of a room 30' x 20' painted light green, with basic florescent lighting. Before and after the environmental design manipulations, the classroom was returned to this baseline condition. During each of the 8 baseline phases, behavior ratings were recorded during 2 observational sessions.

The environmental condition which comprised Experiment I, consisted of the manipulation of the color of the classroom walls from light green to red. This

was accomplished through the use of wall panels and completed over the week-end to avoid interference with classroom procedures. During this manipulative condition, behavior ratings were recorded twice, one session on the first day of the environmental change and again on the last day in which the experimental condition was to exist within the classroom. The classroom was then returned to the original baseline condition, and again, student behavior was recorded for two observational sessions.

Prior to the onset of Experiment II, baseline conditions were continued and two observational sessions again established a baseline of student behavior. The environmental manipulations in Experiment II involved a reduction of space per student within the classroom. A canvas partition reduced the square feet available in the classroom by 20% or from 20' x 30' to 20' x 20'. Following two observational sessions in which student behavior was recorded, the classroom was returned to the baseline condition and behavior was again recorded.

Baseline conditions were then continued until a baseline of student behavior was recorded before the conditions of Experiment III were implemented. Experiment III manipulations consisted of the addition of track lighting added to the ordinary classroom (baseline) conditions. Student behaviors were once again recorded during two observation sessions, baseline conditions were reinstated, and behaviors were again recorded.

In Experiment IV, the previous experimental conditions of wall color (red) and space reduction (20' x 30' to 20' x 20') were combined as a single condition. Again, two observational sessions recorded student behavior and conditions were returned to baseline. A baseline of behavior was again established following the experimental condition.

Recording of Behavior

Four graduate students in Special Education at Northern Illinois University underwent an extensive 3-week program on the utilization of the behavior observation and coding procedures to be used during the experimental conditions. This training program consisted of practice in coding behavior from a video-tape of the actual subjects from one week and in-classroom observation for two weeks. The two weeks of in-classroom observation also reduced the novelty effect of the observers presence within the classroom for the subjects and the teacher. The observers were asked to define their own discriminative indicators when observation of idiosyncratic behaviors caused observer confusion. These problem areas were discussed and such behaviors were defined in relation to peg behaviors to be recorded.

Changes in environmental conditions or a return to baseline conditions always occurred on a weekly basis (i.e., beginning on a Monday/ending on a Friday). Observers were randomly assigned to a partner observer each week. Observation teams were then randomly assigned to a Monday (i.e., the first day of environmental changes or return to baseline conditions) or a Friday (i.e., the last day of ex-

perimental or baseline conditions) observational session. Each team observed both classroom periods for that day. Ten observations were made on each subject during every session.

Two areas of key behavior were delineated and specifically defined for the purposes of coding: 1) On-task behavior was defined as the Subject's head/body orientation toward assigned work including some type of on-going physical manipulation (i.e., visual scanning, hand manipulation, etc.), and 2) Ambient-task movements were defined as any significant bodily movement not oriented to or necessary for completion of the Subject's instructional task. The coding of ambient-task movements was broken down further to the designation of 3 main bodily areas from which movements originated: Head movements, torso movements, and limb movements.

An interval observational strategy was used incorporating ten, ten second interval observations for each subject during each observational session. Observers were equipped with a cassette recording from which auditory instructions regarding the beginning and the end of the 10 second interval were delivered through a small ear plug. The use of the one-ear plug system as opposed to the head phone system enabled observers to remain in complete auditory contact with classroom occurrences while simultaneously receiving systematic instructions regarding observational procedures. The order in which students were observed was pre-selected randomly for each observational session for the purpose of reducing any possible sequence effect. Although each Subject was observed for 10 intervals during a session, each Subject was observed once before the second set of observational intervals began. This procedure was continued until all Subjects were observed for 10 spaced intervals. This process insured a wider sample of behaviors over the entire observation period and different aspects of classroom instruction.

Consistent periodic check of inter-observer reliability yielded high reliability coefficients throughout the study. Coefficients were determined by comparing each interval of the two observers, any discrepency in coding was calculated as a faulty interval. The session number and corresponding inter-observer reliability coefficients follow:

Room Condition	Session	Reliability Coefficient
Lt. Green	1	.89
Red	4	.92
Lt. Green	8	.84
Reduced Space	10	.87
Lt. Green	13	.88
Lighting	15	.87
Lt. Green	20	.90
Combination	22	.90
Red & Reduced Space		
Lt. Green	24	.90

RESULTS 4

This sponsored research effort produced findings in two separate areas. The first results come from a questionnaire sent to interior designers, architects and special educators (ecological psychologists, parent find groups). The second results were achieved by running a controlled study in a state residential mental health/mental retardation center. The first mention study results will be reported first, and the study will follow.

Survey Results

Based on the data collection, a listing of criteria, desired attributes or characteristics that the interior educational setting for mentally retarded youths should have was compiled. It is a set of guidelines that the designer architect or special educator may find helpful in determining the appropriate physical environment. The criteria are not a static recipe, but rather it will be situation dependent, where the decision makers will need to determine priorities, values, and the relationships of these guidelines to the programs they are implementing as well as user requirements. The user requirements should include consideration for the staff (teacher, therapists, administrators) as well as the primary users.

Performance criteria also becomes a document (in either written or visual form) that enables a designer and client such as a special educator, to communicate on the issues in the physical setting and to determine whether there is an agreement or rapport concerning the direction the solution should take.

Obviously, the environmental impact on the staff may also affect the smooth functioning of the program, the delivery of services and consequently the well-being of residents. These criteria are not intended as a substitute for discussions with staff, contact with the mentally retarded residents nor in lieu of site visits to other architecture. Rather, the criteria is intended as a supplement to these other critical phases of data collection in the design process. Presumably, the designer or architect will be developing a program which defines the problem, lists the objectives, includes a user-profile plus performance criteria, such as is included here.

This is part of what is called the design process, or rational problem-solving method which is increasingly being used by designers and architects to help insure that the problem is well identified before concepts or solutions are developed. Such information means less dependence on intuition or subjective judgment.

The intention is that the physical setting be supportive of the program at the institution and aid in its implementation. The environment then becomes part of the program or service delivery system in the institutional setting, supplementing the humanization and normalization process.

The following results are of the survey of the ef-

fects and validity of light, space, and color on human behavior.

Function: The main purpose of the classroom is to offer an environment geared to the most efficient methods of learning and education. In the Special Education classroom, the variables of the evvironment are of even more concern than in the regular/ normal classroom environment. These variables have an influence in relation to the behavior of the students. Color, space and light are the variables of the Special Education classroom environment that are being researched for their most efficient and effective characteristics with the Special Education environment.

Environmental Characteristics Found To Be Of Concern To Special Education

Color	Space	Light	Color and Light/ Space and Light	Color, Space and Light
Colors are a direct experience, without intermediary and have an immediate effect on mood and feeling. Warm colors make the time seem to pass slower and encourage people to keep on the move. Cool colors give a receding visual effect. Color can contribute to the aesthetic impact and visual effectiveness of the environment.	Children's space should be friendly and pleasant so they can recognize it as their own. Furniture should be scaled to their size. Relationship of object in space to the self external spatial relationship helps permit the judgment of distance or time in space--temporal awareness. The higher the quality of the space in a center, the more sensitive and friendly the teachers.	Variety and contrast in lighting intensity are stimulating, if too excessive they can lead to discomfort and glare. Florescent lamps can cause, or at least aggravate, hyperactivity. Correct light waves or background radiation can counter hyperactivity. Limited glare, good light distribution and good source brightness are important to an effective learning environ-	Sharp contrasting shadows provide handicapped children with more cues and information about their three dimensional surroundings. (S/L) Color can help remove glare from a field of view (desirable). (C/L) With softer surroundings, cooler hues and lower brightness there is less distraction and better concentration on visual and mental tasks--good inward (orien-	If a certain color is required it is necessary to specify hue and also illumination under which it will be seen, and take into account the effect of the color on surrounding surfaces. Too much stimulation of any type has the same effect as too little in some children it interferes with learning behavior. Need an atmosphere of structured informality to promote social involvement with physical movement; intellectual and aesthetic stimulus.

Color	Space	Light	Color and Light/ Space and Light	Color, Space, & Light
Warm and luminous color is related to muscular response, action and attitude Children react strongly to color and it should be chosen carefully. Excitably individuals respond more therapeutically to stimulating colors and withdrawn individuals to cool colors.	Space should keep children involved and interested (with equipment and each other) for good social development. Space communicates with people--what's in the space and how they're arranged.	Florescent lighting systems with diffusing or refracting material below is the best and most practical for the classroom. Room size, form and scale has a definite bearing on the effectiveness of information transmitted to the child. Artificial illumination should include some measure of ultraviolet radiation comparable to sunlight. Spectrum of light emitted should be continuous. Lighting should not be a pure white light but a combination with natural and other levels. Lighting should not be a consistent, monotonous intensity. High levels of illumination with warm and luminous colors in surroundings makes the body tend toward outward orientation (increase in alertness, outward orientation).		The content of the environment must support the goals stated. Programmed and cycled both in color tone and brightness will equal a pleasing and necessary variety, as in nature. 100 ft. candles is sufficient with colored walls; visual comfort and emotional pleasure is greater with colored walls. Lighting should be medium to moderate brightness. (color/light). Individual factors (motives, needs, appetites, interest, expectancy, anticipation) are effected by these variables. Environmental factors: size of object/form, repetition of, intensity of brightness of an object or form, object-to-background contrast (brightness or color contrast) is also effective.

Color	Space
Bright colors increase staff morale and heighten activities of the children. Color affects muscular tension, corticle activation (brain waves), heart rate, respiration and other functions of the central nervous system.	Attractive, colorful and exciting atmospheres stimulates the child's imagination and makes him want to use his muscles. Must understand the contents and the empty space of an area to see how they function as a whole. Complexity and variety is necessary for good space utilization. The shape of the space and the distribution of the objects in the space must allow teachers to see and be seen.

Questionnaire

Questionnaires were sent to two groups: special educators and designers/architects who had designed special education centers or institutions for mentally retarded residents. Samples of the questionnaires are in Appendix ___.

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The following data is a compilation of the results resulting from the national survey.

TITLE
Special Education Questionnaire

Type of Existing Classroom:
- rectangular
- contained
- structured
- large - "home like"
- open with dividers
- large with interest corners and time out
- self-contained with restrooms

Size of Existing Classroom:
- 20' x 25'
- 20' x 20'
- 30' x 48'
- 28' x 28'
- 28' x 32'
- 20' x 40'
- 30' x 30'
- flexible
- average
- small
- 750 sq. ft.
- 166 sq. ft./pupil
- 600-980 sq. ft.

Lighting in Existing Classroom:
- florescent*
- white neon recessed in ceiling
- combination - florescent, incandescent and mercury vapor
- natural
- good

65

twice as most schools
standard
adequate
recessed

Color of Existing Classroom:
tan walls
light wood stain doors
pastel metal doors
drab lumberyard sales
baby blue
light blue, gold or beige*
green
bright*
cheerful
geometric patterns
brown brick in room/wall in burlap blue or brown pastel**
green chalk board
carpet - orange tweed
white tile
yellow bulletin boards
light
orange, yellow, greens, red, plum

Rationale of Existing Classroom:
staff planned with architect
availability
age
integration
economics

Rationale for Size of Existing Classroom:
related to number and age of students
traditional 1950 rationale

limited by property availability
only one available
flexibility depending on needs
designed to meet attitudes of Superintendent and Director of Special Education
instructions to architect - no long wall, no institution effect
size relates to furniture arrangement and movable walls

Rationale for Color of Existing Classroom:
director liked blue
create warm, comfortable feeling
for light feeling
pastel - most pleasing, easy to be in for a full day
color graphics for cheerful atmosphere and motivation

Rationale for Light in Existing Classroom:
traditional 1950 - poor
create warm, comfortable feeling
architect requirements

In Agreement with Existing Classroom:
good - minority
NO - majority

Extent of Change in Existing Classroom:
add vocational facilities
enjoy more space, variety of color - less monotonous
use yellow/light green, add murals and art work
carpet

personal touch of children - not too sterile
wish it were larger
add more electrical outlets

Relationship between Physical Environment and Behavior of TMR Children?
pleasant environment - favorable effect - teacher makes difference
none
yes
respond positive to warm colorful environment
some
pleasant working conditions - more satisfied staff - more satisfied pupils
psychological environment more important than physical
color as accents
atmosphere - motivating factor with older students; feeling of acceptance and warmth affects behavior in positive way

Differences in Behavior Due to Light/Space Color?
yes (some)
no (lot)
bright with color
sunny weather good and vice versa
more manageable
no way to measure
cannot evaluate
new building - teacher attitude change - student, too

Information Valuable to Special Education Design?
yes - majority
doubt it - money indicates most decisions, not needs of children
variety of stimuli
easier to pinpoint negative aspects

Physical Setting Trends in Special Education?
National Association for Retarded Children (NARC)
baby blue uniforms - no benefit
large
area for tables
play area
closet
sink
bathroom
able to handle multiple handicapped students
crisis rooms (time out)
space for study carrols
normalization rather than isolation
move out of self-contained classroom
focus more attention on entire school setting
effective use of space
specialized areas
non-conventional architecture

Studies Conducted on the Effect of the Physical Environment of Trainable Mentally Retarded (TMR) Children?
NARC
Council for Exceptional Children (CEC)
Exceptional Children
Teaching the Mentally Handicapped
Marymount Manhattan College - N.Y.
Dr. Steve Schain - Governor's State University, Park Forest South, Ill.
ASP Journal on Color

Suggested Sources for Studies:

NARC
CEC
American Association for Mental Deficiency
TMH Center - Murphysboro
Ed. Breen - Special Education Department - SIU, Carbondale
Murray Children's Center, Centralia

Special Education Centers:

Laramount Center, Lake County
Kirk Center, Palatine
Beekman Center, Lansing, Michigan
PARC Center, Peoria
Tri-County Special Education School - Murphysboro
Arizona Training Center, Tucson
Naperville Century Hills (Round School)
Niles Township Program - Molloy Education Center
Hope D. Wall - Aurora West Public School
Waukegon, Dew Center
NSSED
SPEED - 1125 Division Center, Chicago Heights, Illinois
Robert A. Jamieson School, 2721 W. Richmond Blvd., Peoria, Illinois 61604
Mid-Valley Special Education - St. Charles
Century Hills Education Center

Interested in Results:

ALL

TITLE
Architect's Questionnaire

Special Education or MR Institutions Designed:

Currently completing prototype design of "special spaces" for autistic children at a treatment facility in San Francisco
Environmental Therapy Complex - Forrest Parks School for Physically Handicapped Children, 1969, Orlando, Fla.
Bartow Special School (TMR) Env. 1975
The Child's Creative Learning Space - 1971
Exterior Sensory Stimulus Environment for Miami C.P.
Specialized Living Centers for the Developmentally Disabled
Master Plan, Elementary School - Multi-Handicapped Unit, Maryland
City Wide Magnet School, Disney Magnet School; Chicago
Remedial Reading Center: Broward County, Fla.
North Community School; Springfield, Mass.
P.S. 398 - Brooklyn
Lincoln Campus, Mich.
Skilled Nursing Care Facility for Multi-caps
Mark Twain H.S. for Emotionally Handicapped; Rockville, Maryland
Didlake School and Muriel Humphrey School - Virginia
The Zuni Presbyterian School - Virginia
Thomas Jefferson Jr. High School and Community Center, Special Education Department - Arlington

Features Believed Vital in Designing Environments for TMR Children:

Small individual personalized teaching units
Flexibility to introduce change in physical environment to permit changing programs
Separate and defined circulation patterns by age groups, visitor, service, etc.
Quick aggress and safe circulation (no architecture barriers)
Limited, safe window areas
Specialized communications systems
Provide space conducive to mental and physical learning with proper aids and provide such environment which eases the task of the teaching staff
Sound Warning Systems for emergencies, proper toilet facilities as close to the same type as used for normal environments
In general, humanization/normalization of the living milieu
Unification of traditionally fragmented elements of the environment
Complexity not over simplification
Use of multiple levels above the ground plane
Textural and color variety
Non-objective forms rather than (chicks, horses, etc.--ugh!)
Everything--the set or image of the physical environment must be clear to the child's perception--this makes it very difficult to isolate the effect of individual environment variables.

Criteria or Rationale Employed in Design of Space/Color/Lighting:

External cues demaracate the changes for the child from level to level of his therapy--external cues need to be trustworthy, firm but never overwhelming
Space--attempt to unify all parts of each environment into a flowing sequence of related spaces and levels. This encourages movement and inspection. We create a multiple range of enclosed, semi-enclosed and open design to give choice--use multiple levels above ground to encourage verbal communication.
Color--no set ones to use--tend to use bright and lots of color; encourage children use of coloring the environment
Light--use natural light outside. Try to create semi-dim spaces.
Our own
The normalicy relationship
Due to work in the past, we used our knowledge and intermixed this with the client's expertise.
In most cases the design criteria has been to provide smaller self-contained units for individual student-staff relationship with a personal atmosphere of some natural light, controlled overhead lighting, and subdued warm color tones for the walls and carpeting. The main use of brighter colors has been for accents, graphics or as a major use in the more defined areas of intermingle activity or physical development.

Sources Used to Determine Characteristics and Needs of Children Relative to Color/Space/Light:

- Staff instructors input, firm experience, Virginia's School Planning manual, Guide for Planning Education Facilities by CEPP.
- Little available--own experience
- Direct observations of our environments
- Mock-up spaces
- Munch, intuition and guess

Trends in Design of Special Education Center to be Aware of:

- The retreat from institutional layouts in planning
- De-emphasizing of utilitarian, low maintenance materials
- Scaling facilities to the size and special needs
- Facilities and programs in foreign countries
- Minimize student interaction
- Low profile image rather than ones of "big school"
- Staff development and specialized research to be accommodated as well
- Flexibility and adaptability
- Avoidance of creating disfractions
- Avoidance of creating a dependency on the learning environment

Correlation between Physical Environment and Children's Behavior?

- Yes--an orderly, pleasant environment helped behavior--free of distracting stimuli
- Yes**
- Data not available

Problems of Hyperactivity in Design Considered:

- Results from boredom--stimulating environment does not over excite
- Yes
- Considered--but designed to fit total needs

Did Physical Setting Control Hyperactivity?

- Difficult to determine
- Sometimes
- Yes--space enough to move from one interest to another; child needs to occupy space he can identify as his own

Other Studies Done Related:

- Humphrey Osmond: Mental Health Institutions
- "Light on Growing Children", Architectural Forum, February, 1946, D. Harmon
- Lot of British studies in Architectural Psychology Newsletter
- Bettleheim: A Home for the Heart
- Lou Bowers - College of Physical Education, University of Southern Florida
- Infant Developmental Environment (R&D Project, Sunland Hospital, Orlando, March 1972, James B. Vass)
- Yes
- Not specifically

Would You Find Studies Useful:

- Yes**
- Not yet
- Sure

Designers or Architect to Contact:

Hertzka, Knowles, 25 Main Street, San Francisco
Kaplan, McLaughlin, 407 Jackson, San Francisco

Other Sources:

"Effects of Classroom Lighting on Child Development", Bernard Combs
Functional Color for the Classroom, Brunswich, Balke, Collender Co., Chicago
School Environments Research, Environmental Abstracts, University of Michigan
Colors for Interiors, Faber Bihen, N.Y., Whitney
Patterns for Designing Children's Center - Educational Facilities Lab.
NARC
Journal of Applied Behavior Manual

Special Education Centers to Look at:

Blueberry School, New York
Orthogenic School, University of Chicago
United Cerebral Palsey Center, Brooklyn, N.Y.
Mark Twain School, Montgomery County, Maryland

Interested in Study Results:

ALL

Study Results

Color. This study measured four separate environmental variables through structured observational procedures. The first variable measured was the effects of color (burnt orange). The natural institutional color was first introduced and the new color was introduced a week later. Three factors were broken out in the analysis. First, the effects on the color on all 13 subjects. Results demonstrate that ambient behavior associated with hyperactive behavior was not increased by the color change. Among the 13 subjects, the new color resulted in reduced ambient behavior. The results do show that while the first group of subjects ambient behavior was reduced, the second groups behavior increased, but not at a significant level. The results also indicate that there is no correlation between ambient behavior and on-task behaviors. While ambient behavior was generally reduced, on-task behavior remained stable. This was true for the 13 subjects, the two groups, and between males and females. The observations related to this variable also illustrated that more hyperactivity existed at the beginning of the week (Monday) when the new variables were introduced than at the end of the week (Friday). This pattern was consistent when measurements first began with the neutral color, persisted with the introduction of the new control, and continued when the setting was returned to its neutral status.

Space. The Monday-Friday pattern did hold when dealing with space, except for the female subjects. There ambient behavior consistently increased during the week, both when the neutral space existed and when the reduced classroom space was introduced. The results also demonstrate that change in space had a more profound negative effect on the on-task behavior of the female subjects than it did on the male subjects, whose on-task behavior resulted in no measureable change. The space reduction resulted in increased on-task behavior for the 13 subjects and for each of the two groups, composed of the same

subjects. The findings indicate that the space change had a greater effect on the second group than it did with the first. Ambient behavior was reduced by the space change for the 13 subjects and their two groups, but this effect was not significant.

Lighting. Ambient behavior was increased by the introduction of incandescent lighting among males, and the effects of the lighting was not reduced through the factor of time. Conversely, lighting resulted in less ambient behavior among female subjects, and the ambient behavior increased when the lighting was returned to the total florescent system. Light, other than the male, female mixed, demonstrated no significant behavior effects.

Space-color. This combined variable had a greater effect on female subjects ambient behavior than it did on the behavior of the male subjects, whose behavior was little effected. The combined factors also resulted in increased on-task behavior for the female subjects, when compared to their prior behavior before the introduction of the new variables. The combined factor also reduced ambient behavior among the 13 subjects and between the two groups when compared with their behaviors prior to the introduction of the space-color factor. The combined variable also tended to reduce on-task behavior, but again, like all other variables, the results were not significant. The combined group graphical had a greater behavior change (19.4-9 neutral; 7.8-7.4 change) (see Figure II).

Across variables. Female subjects across all variables tend to have a greater behavior change than did the male subjects as illustrated in the graphs. This held for both ambient and on-task behavior. The second experimental group tend across variables to exhibit greater ambient and off-task behavior. Across all subjects, the data does not demonstrate a consistent pattern of behavior.

CONCLUSION & RECOMMENDATIONS 5

This study demonstrated several issues concerning environmental concerns in the Special Education classroom. The first and most significant factor demonstrated through the questionnaire is that there is not uniformed agreement among involved professional personnel on the structure of classrooms, the colors to be used, how and when the colors should be used. The color variable is an issue which educators, psychologists, designers, and administrators have been debating for 40 years. The study conducted by the investigators of this report found no significant behavior change when the color changes were conducted. This finding appears to challenge the findings first reported by Strauss and Lehtinen (1947) that hot colors tend to result in hyperactivity among educational handicapped students. And these findings of Struass and Lehtiner have influenced the interior design of public and private schools and residential institutions during the past 50 years. There is no substantial audience which demonstrates that neutral colors are more or less effective aids in prompting the education of the handicapped. What this study has demonstrated that there is not an increase in ambient behavior when a warm color is introduced into the classroom; and the color does not effect on-task behavior.

The questionnaire and study demonstrate also that there is inconclusive evidence on the physical factors, such as space, influence on ambient and on-task behavior. Data from the questionnaire indicates there is no uniform finding or attitude on how the room should be structured. Factors of space allotment, use of partitions, and types of furniture used has not been well delineated. There is a general agreement that space should be controlled and the furnishings should interface with the physical and learning needs of the students. This study has demonstrated that there is a tendency of handicapped students to reduce their ambient and on-task behavior. The intent of environmental change in this case was to reduce ambient behavior, but to increase on-task behavior. Thus, the study demonstrated did not occur, though the reduction of on-task behavior was not significant. Since the 1950's when Cruickshank (1959) reported that disruptive behavior was reduced through the use of correls, the assumptions have been that reduced ambient behavior also resulted in improved on-task behavior. This study challenges the 1950's assumption, and generates new questions. Among the questions arising from this finding are, first, what level of ambient movement must be maintained and tolerated; second, what room size and conditions results in reduced ambient behavior and increased on-task behavior; and third, are there different variables and factors for males and females?

On matters of lighting, there have been a series of disputes and contradicting findings revolving around the issues of incandescent vs. florescent illumination. The questionnaire and literature search results tend to indicate that florescent is the most effective illumination system in the classroom, and the just completed study does not contradict this finding. Where both florescent and incandescent light is used, the incandescent lighting increased

ambient among males, did not increase the same behavior among females, and did not significantly effect the on-task behavior of the subjects. The effects of florescent lighting challenges the contention of some researchers that contend continuous flow illumination, generated by incandescent lighting, results in less eye fatigue than florescent lighting, which is a pulsating illumination. There is no data that substantiates this position.

The combination size, color variable reduced on-task behavior, while having little effect on ambient behavior. It appears from the data that size, more than color, is a controlling factor, since each time room size was manipulated ambient behavior was reduced. This finding, again, places in question that 1940's and 1950's contentions that room color and teacher clothing were a more significant influence on behavior than any other factor.

While there is no demonstrable reason why female subjects appear to have a greater response than males to environmental change, the data points to this greater response. Differences in psychological composition, the structure of their peripheral or central nervous system, and the physiological structure may influence the nature of the female response. No data gathered either through the questionnaire or study points to the underlying factors which resulted in the female subjects behavior.

Conclusions

This study is not the definitive work environment variables and their influence of the learning behavior of handicapped, institutionalized adolescent youth. The research into environmental influence on all students with compelling learning problems is scant, and it is macrocosmic on issues of adolescent behavior. The lack of research on the ecological influence on learning of the handicapped adolescent, and the lack of efficacy of training programs for adolescence requires additional research.

Of all the variables investigated, the factor of space appears to be the most influential. Space manipulation has been a primary manipulated variable in Special Education (Cruickshank, 1966 and Haring & Phillips, 1972). It is evident that space variable must be investigated more thoroughly. This study found that space did reduce ambient behavior, but it also reduced on-task behavior. Questions, thus, must be raised as to how space is to be manipulated so ambient disruptive behavior can be reduced and on-task learning can be increased. Such future studies (i.e., space) should be studied as single factors in which the factor is continually manipulated over a long period until to optimum space is determined under specified controlled conditions.

Male-female factor, along with space, should also be investigated further. This study demonstrates determination in response to the variables by the sexes, but this difference was not significant. The findings do recommend further investigation. If males and females do vary significantly in response to some variables, this must be determined.

The success of students during task may be influenced by their classroom placement of their proximity of dividers, colors, or other ecological factors. The male-female factor may be influenced by social-influence which are ven now not fully understood, and requires heightened investigation.

It is thus evident from the questionnaire and study results, that further study must be conducted on the influence of ecology to behavior and learning. Among the issues that must be investigated are:

A. What types of room construct results in increased appropriate behavior and learning among adolescence?
B. What form of illumination results in reduced eye fatigue and improved visual perception?
C. Which color produced increased on-task learning among handicapped adolescence?
D. How are such design and decorating decisions made?
E. Are there differences required for severe and mildly handicapped youth when compared to non-handicapped youth?
F. Do self-contained educational careers for trainable and severely handicapped youth result in increased or decreased learning?

These are but a few of the major environmental issues that must be explored further if optimum educational experiences are to be provided adolescence. The handicapped adolescent is often the disgarded student of the educational process. This cannot be allowed to continue. Improved environments and instruction must be provided the handicapped youth.

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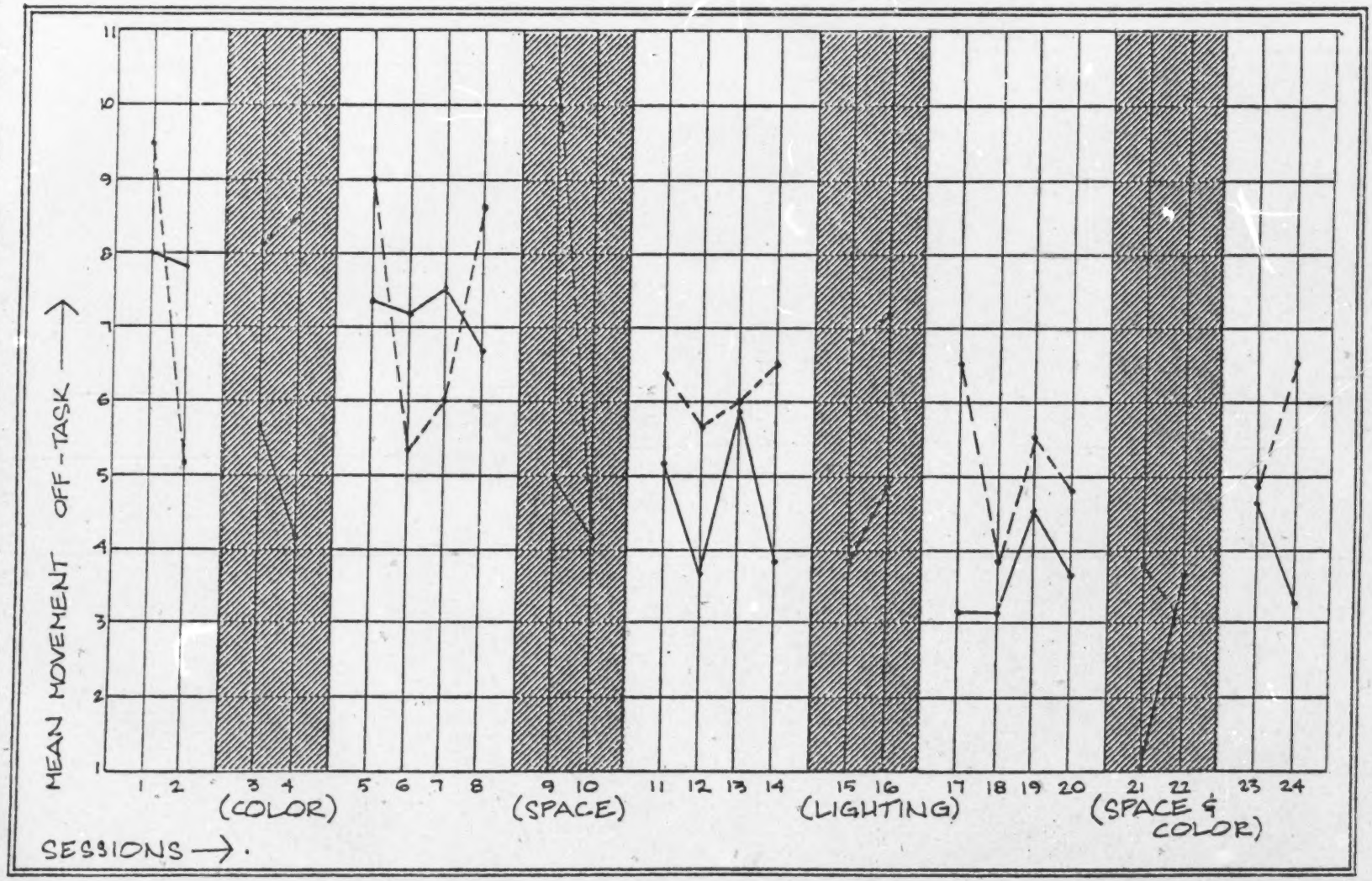
KEY

COLOR - RED PANELS UP
SPACE - CURTAIN UP
LIGHTING - TRACK FIXTURES IN USE

FIGURE 3

MEAN MOVEMENT
OFF-TASK
CLASS I ———
CLASS II - - - - -

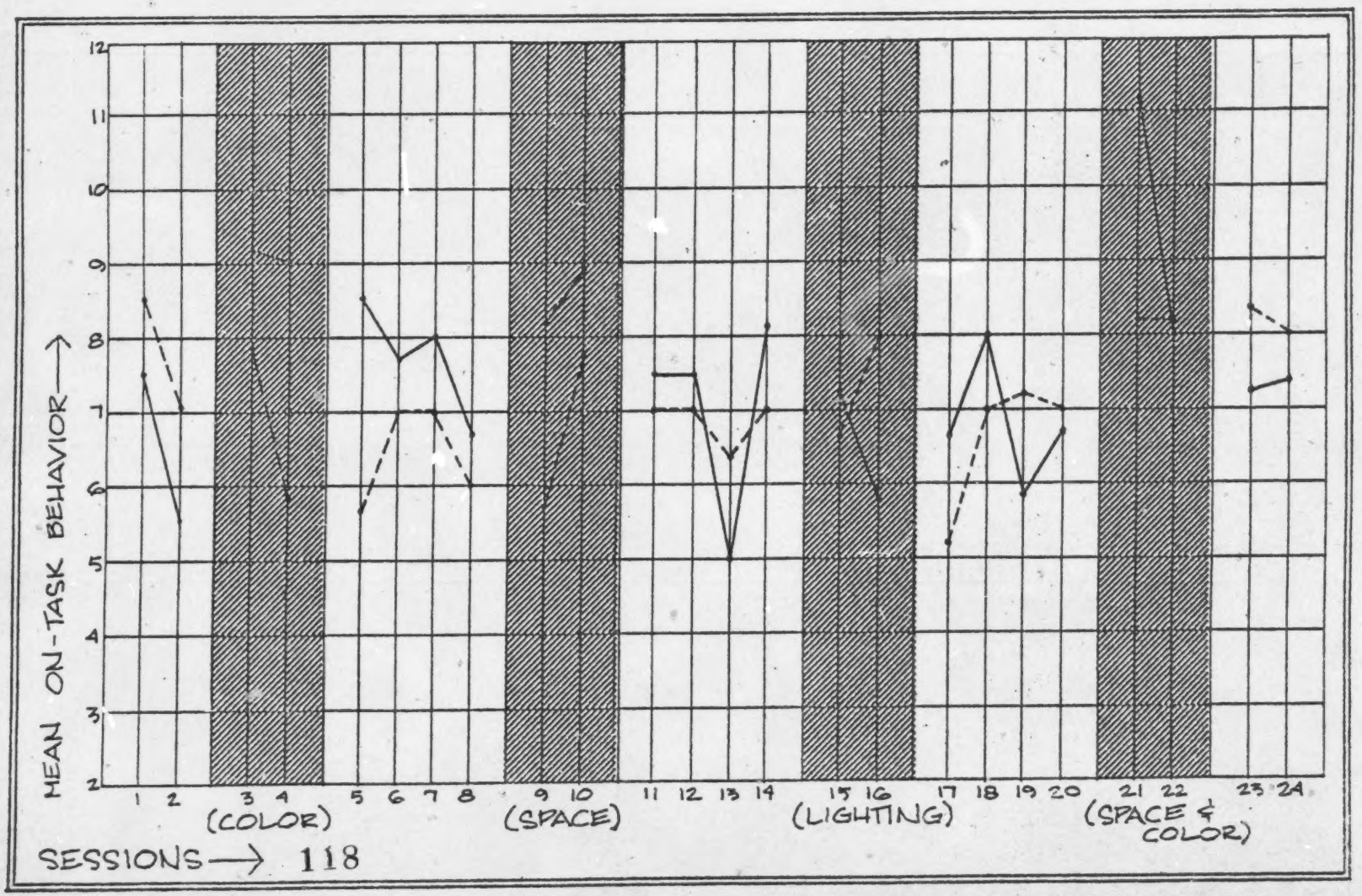


KEY

COLOR - RED PANELS UP
SPACE - CURTAIN UP
LIGHTING - TRACK FIXTURES IN USE

FIGURE 4

MEAN ON-TASK BEHAVIOR
CLASS I ———
CLASS II - - - - - -



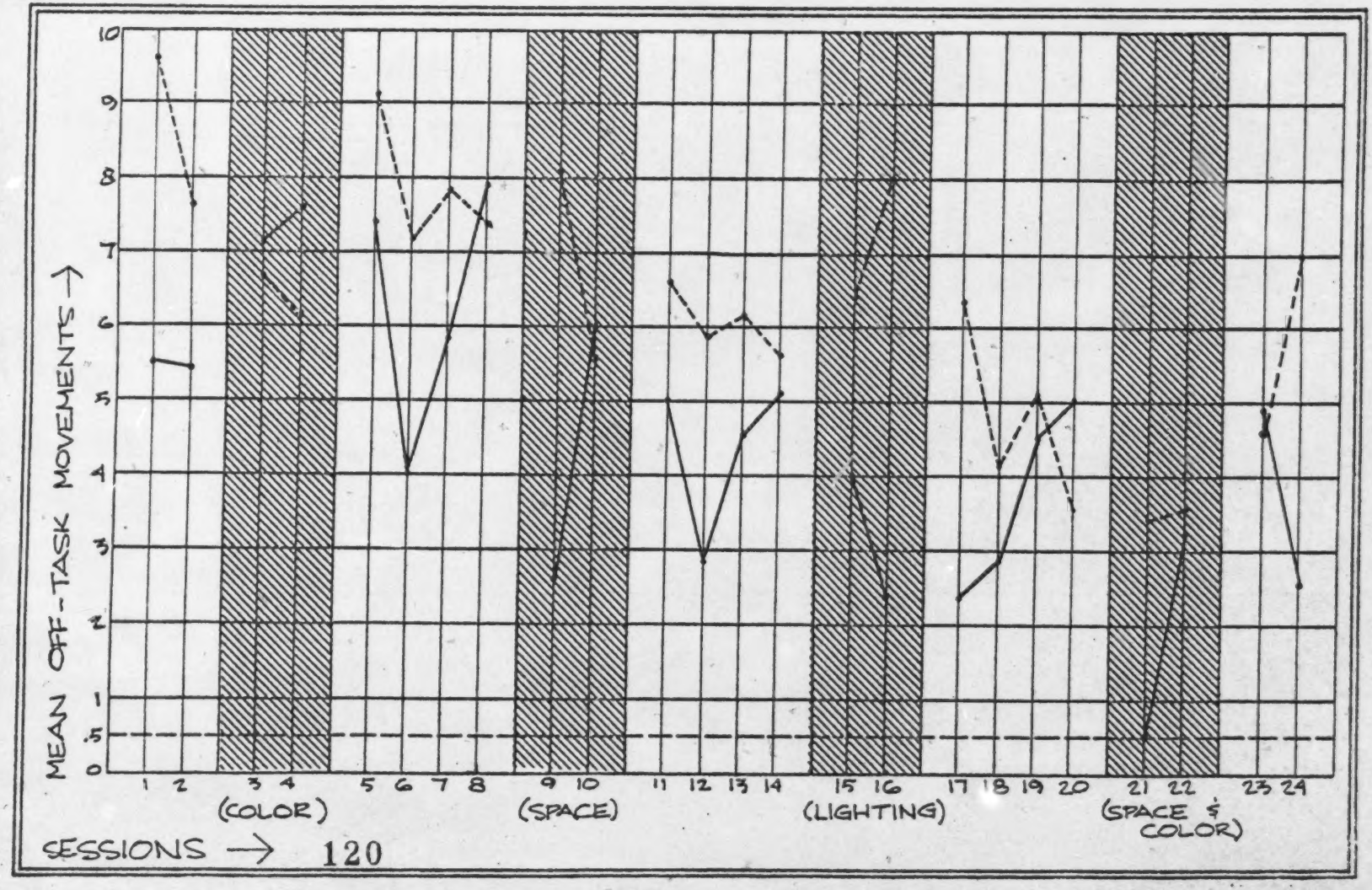
KEY

COLOR - RED PANELS UP
SPACE - CURTAIN UP
LIGHTING - TRACK FIXTURES IN USE

FIGURE 5

MEAN OFF-TASK MOVEMENTS

MALE ---------
FEMALE ———



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KEY

COLOR · RED PANELS UP
SPACE · CURTAIN UP
LIGHTING · TRACK FIXTURES IN USE

FIGURE 6

MEAN ON-TASK MOVEMENTS

MALE ---------
FEMALE ———

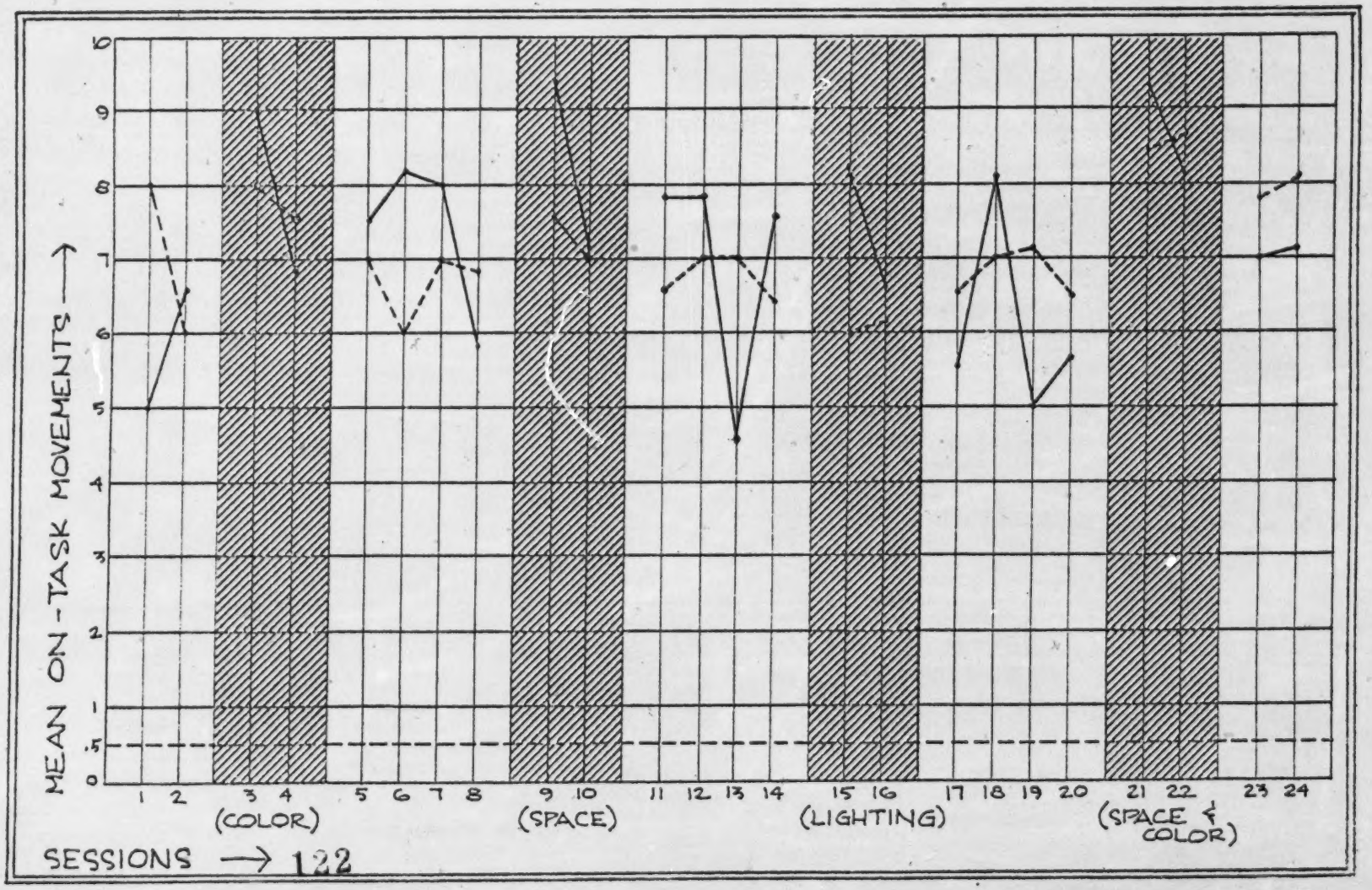

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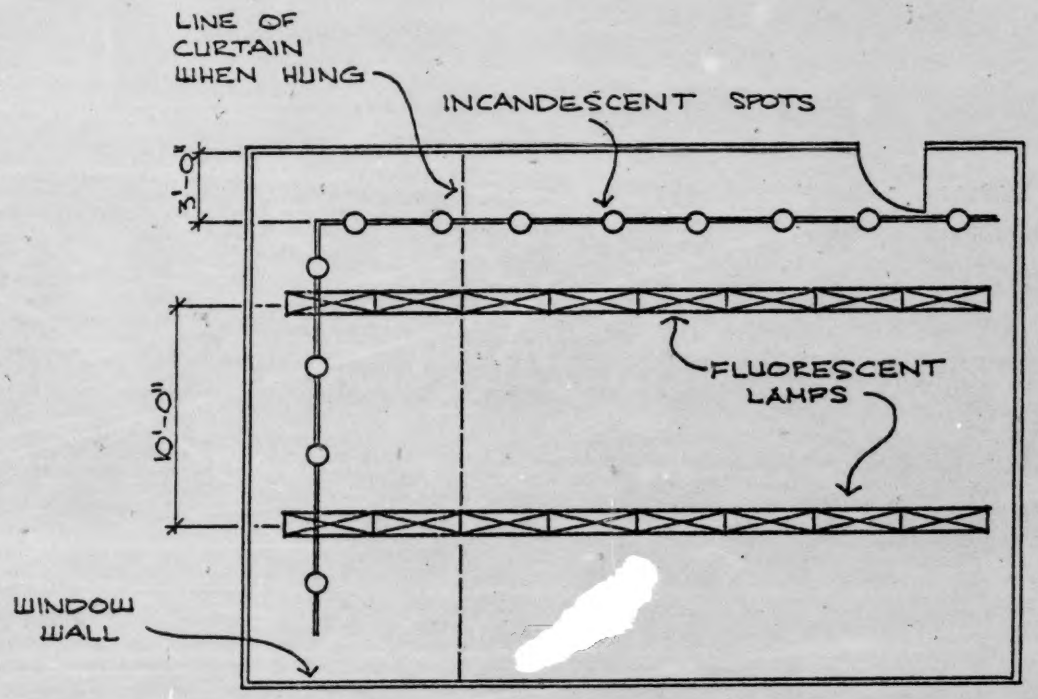
DIAGRAM 1

LIGHTING PLAN



NOTES:

HEIGHT OF LIGHT FIXTURES:
10'-6" (FROM FLOOR)
8'-0" (FROM TOP OF WORK SURFACE)

12 INCANDESCENT SPOTS DIRECTED TOWARD PAINTED PANELS; LIGHT REFLECTED OFF PANELS INTO THE CLASSROOM.

2 ROWS OF FLUORESCENT FIXTURES; 2 TUBES PER LAMP

NATURAL DAYLIGHTING FROM WINDOWS ALSO AVAILABLE.

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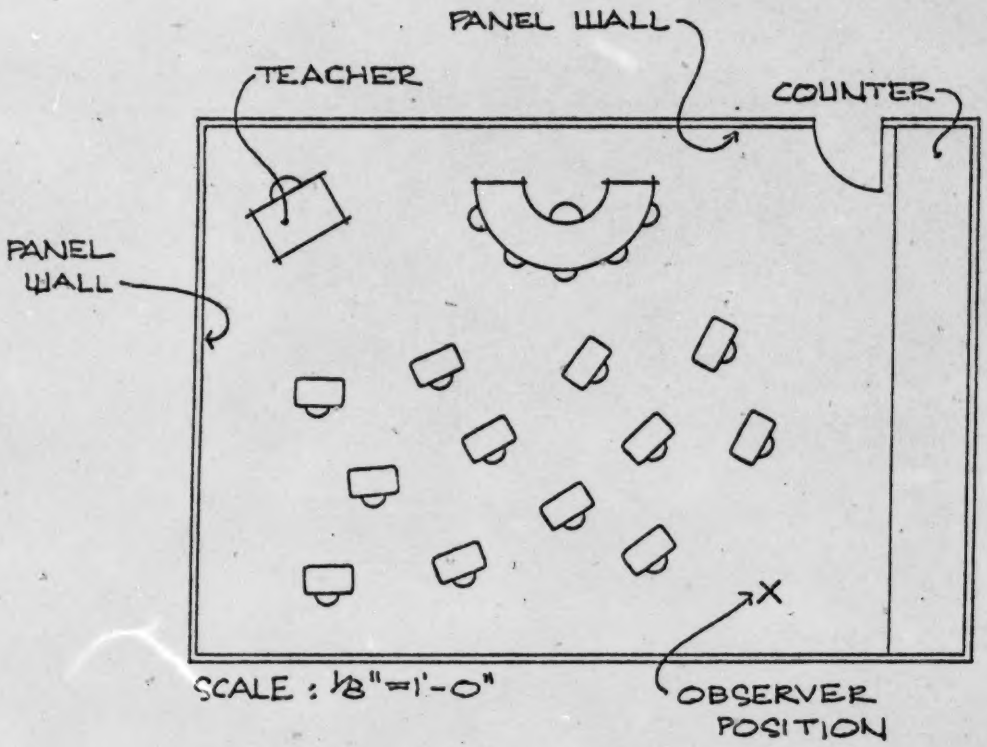
DIAGRAM 2

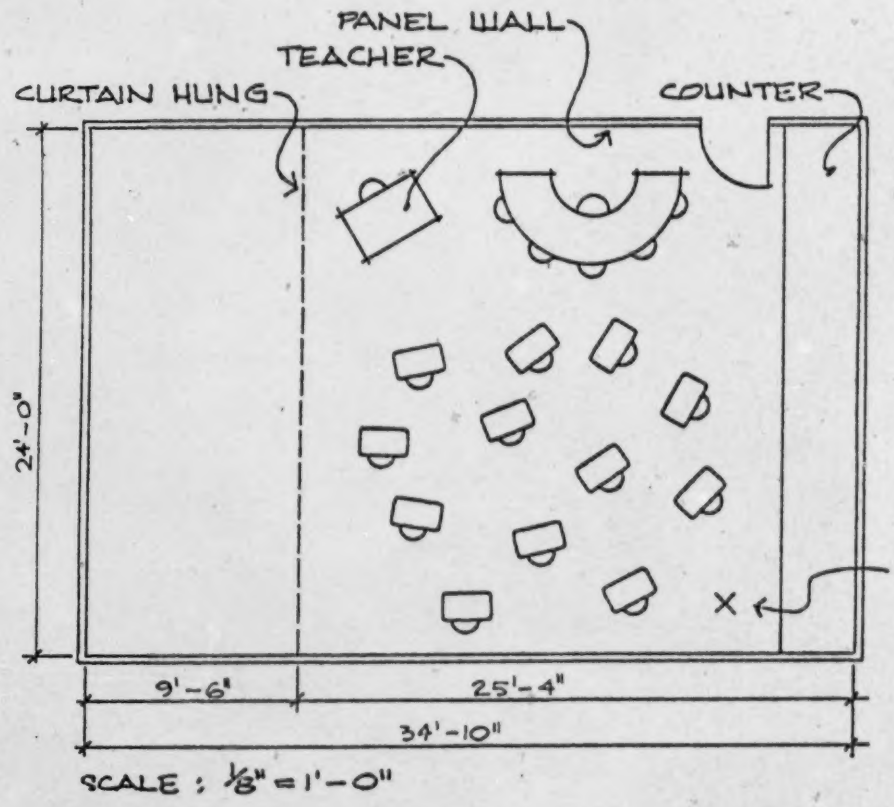
CLASSROOM PLAN;
FULL SPACE CONDITION



NOTES:
FLOOR PLAN OF CLASSROOM REPRESENTING FULL SPACE CONDITION

DIAGRAM 3

CLASSROOM PLAN;
REDUCED SPACE CONDITION



SCALE : 1/8" = 1'-0"

NOTES:
FLOOR PLAN OF CLASSROOM REPRESENTING REDUCED SPACE CONDITION

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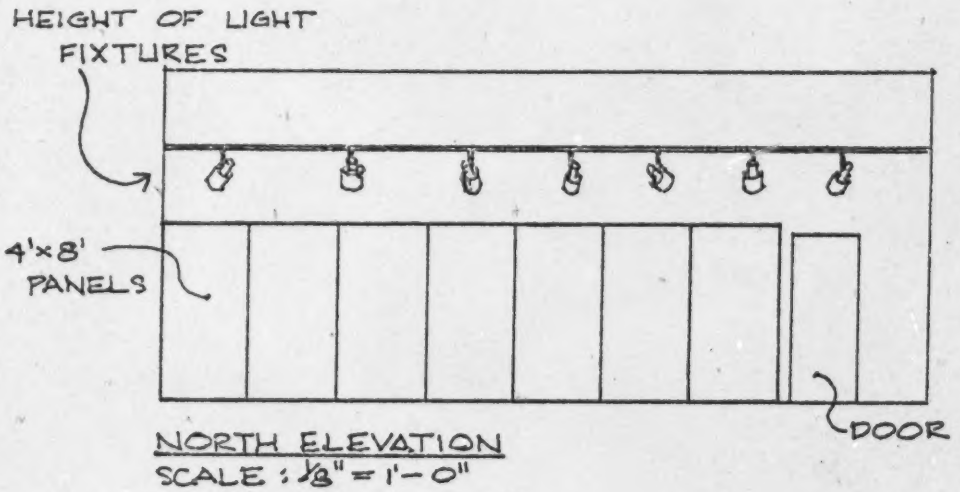
DIAGRAM 4

CLASSROOM ELEVATION; WALL PANELS



NORTH ELEVATION
SCALE: 1/8" = 1'-0"

NOTES:

4'x8' MASONITE PANELS, PAINTED ONE SIDE GREEN, REVERSE SIDE RED. PANELS MOUNTED ON FIRRING STRIPS ON 2 WALLS (SEE FLOOR PLAN), ATTACHED WITH SCREWS TO FACILITATE DISMOUNTING TO REVERSE COLORS.

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PRIOR RESEARCH PROJECTS - LIGHTING AND HUMAN BEHAVIOR

One of the investigators on the study in this report has been involved in other similar studies. These studies are summarized here for two reasons: to compare data collection methodology and to show two other interdisciplinary environmental investigations that were concerned with lighting.

In deciding upon a particular environmental solution including artificial lighting, the architect or designer makes decisions on the lighting solution based on economic, mechanical or functional criteria. Human use considerations including visual impact may enter into the decision-making process, but little substantial research had been conducted on the relationship between lighting and behavior.

Artificial lighting has been researched with a focus primarily on considerations such as brightness, contrast, glare and reflectance. The studies generally conclude that accuracy and speed of seeing, contrast sensitivity, visual acuity, and the physiological functioning of the eye continue to improve significantly as the lighting level is increased to an optimum point. However, little research has been undertaken to understand man's psychological reactions to the luminous setting particularly the perceptual/psychological processes which affect behavior.

Two separate projects were undertaken with two different groups to study luminous environment-behavior issues. The settings were a "naturalistic environment (classroom seminar or nursery school) rather than an artificial laboratory environment. However the setting was capable of being manipulated to asses the performance of the subjects in the specific luminous circumstances.

The question asked in both cases concerned the effect of changes in illumination (source, position or level) on specific behaviors. The study was a joint effort, involving designers and psychologists each bringing their own expertise to bear on the problem in an interdisciplinary investigation. The desired end result was specific behavior information or performance criteria that could be used by designers, lighting designers, architects and other physical environment decision makers in determining the appropriate physical environment. Another objective was developing an evaluation methodology for use in investigating the physical environment and the "tools" that could be used for this purpose utilizing the collaboration of designer and social scientist.

Investigation I

A Study of the Effects of Variations of Artificial Light Levels on Certain Aspects of the Behavior of Pre-School Children

The Problem

The purpose of the study was to test the hypothesis

that changing the light levels in one room at the test school with respect to their use of the room, the kind of activity carried on, the frequency of movement from one part of the room to another, and /or the level of social participation at which they played. The project was carried out at the Nursery School at Cornell University involving staff from Design and Environmental Analysis and Child Development.

The Investigating Staff

The staff consisted of one designer and two child psychologists.

Description of the Test Site (A University Nursery School)

The Staff: Three professional teachers who were in regular contact with the children during play time.

The Subjects: The fifteen children in the study group were the younger of two groups meeting mornings, five days a week during the spring and fall semesters.

Socio-economic data was not obtained in detail

though the group included eight white, five black, and two oriental children. Nine of them belonged to families classified as business, professional, or academie, including the family of one black and both oriental children. The other six were from stable blue-collar families or families with no regular occupation.

Description of the Test Room: An interior room with daylight coming only through the openings to other rooms. The table activities, such as puzzles, and the blocks normally present in the room were augmented by kitchen and dress-up equipment.

Light Level: Light level was the variable that was controlled systematically. A series of track lights was installed overhead with dimmer controls permitting varying light levels. For this study, however, the three levels selected were conspicuously different. The settings were marked on the control dial so that they would be uniform from day to day. They were:

Low.....9.18 foot candles
Medium.....23.20 foot candles
High.....39.58 foot candles

Room Activities: On eighteen of the twenty-four test days either a special or unique activity was recorded. This was usually something like play-dough which could

be used by several children at a table with fairly constant adult participation. On six days no special or unique activity was recorded. On these days children played almost entirely with standard equipment, improvised their own activities, or depended on a teacher-centered activity such as story reading.

Room Use and Activities

Observation Periods and Light Schedule: The fifteen children were observed for forty-five minutes each day for twenty-four successive school days. The forty-five minutes were divided into three periods of fifteen minutes each. Each day two consecutive periods were at one llight level and the third was at a different light level, with the two alike preceding the one that was different half the time and following it the other half. Each light intensity occurred on sixteen different days.

Data Collection Procedure: The basic instrument for recording room use and activity was a room diagram, drawn to scale, on which the observer recorded the identity, location, and activity of each adult in the room at the beginning of each minute.

The major focus of this part of the study was to determine whether changes in light level in the experimental room influenced the amount of time children spent in the room when they had a choice, the kinds of activities chosen and the frequency of entrances, exits, and movements within the room.

The second part of the study focused on level of social participation, with light levels as the variable.

Results: In general, there was more activity in the room when lights were medium or high in comparison with low. The data does not establish a statistically reliable effect of light level. However, insofar as the data indicates any differences the effect of brighter lights seems to be to make the room more attractive for play activities of all types. The average duration of episodes differed from one activity to another. In addition, there is a slight tendency for duration to be longer with light level high, especially for free-play activities. Both entrances and exits were more frequent at lower light levels, while movements between quadrants became more frequent with increasing light level.

Level of Social Participation: The second major part of the study was an attempt to see if the children's level of social participation, using the categories defined by Parten, would be influenced by light level.

Observation Procedures: The observation of level of social participation were carried on simultaneously with the room use and activities observations. The

light schedule, potential and actual attendance figures, and numbers of children and adults in the room were the same as for the other observations, although some minutes classifiable by the activities code were not classifiable on the social participation scale.

Interpretation of Findings: Insofar as there are differences from one light level to another the results suggest a higher percentage of minutes in solitary play at low light level and higher percentages of associative and cooperative play at medium and high light levels.

Results: Differences among children with respect to level of social participation scores were greater than the differences between light levels for the whole group. There was a slight difference among light levels, however. The data suggests that light makes a difference but not a big difference.

Summary: For the group as a whole, one must conclude that light levels made little difference in the level of social participation at which they played. The higher light levels did seem to attract more children to play in the room and those who spent more time there tended to get higher scores on the level of social participation but none of the factors investigated account adequately for the individual difference.

Investigation II

An Evaluation of Human Performance Related to Lighting in an Educational Setting.

A light (Vita-Lite) which approximates the spectral energy of sunlight has been developed by the Duro-Test Corporation of North Bergen, New Jersey and was selected for use in the present study. It is a commercial flourescent lamp, of conventional geometry, designed to duplicate sun and sky radiation at a temperature of 5500K. This is the environmental light composition which has influenced biological action spectra on the earth's surface. The literature review in this section described research with artificial sunlight lamps which have produced significant responses in plants and animals when compared with conventional interior light sources (i.e., other flourescent and incandescent lights.)

Eating habits, weight gain and other physiological developments have resulted from being under such artificial conditions.

Group Organization

An interdisciplinary group composed of designers, psychologists and an illuminating engineer composed the evaluation team. The study was conducted at Cornell University involving staff from the Center for Improvement of Undergraduate Education and Design and Environmental Analysis. Staff from the Cornell Physical Plant also were involved in the study.

Experimental Conditions: A seminar room was equipped with two independent flourescent light sources, only one of which was "on" in any given seminar hour. The first, "Vita-Lite", was a full spectrum light closely approximating natural light. The second was the satndar cool-white flourescent light commonly used in institutional settings. The physical structure of the lamps are identical, but they are distinctly different in the color of the light they emit. This difference, however, is not so perceptible as to make the Vita-Lite noticeably different to a native person upon entering the room.

The care with which the experimental conditions (i.e., the different light sources) were disquised is evidenced by the fact that only one subject indicated (on a follow-up questionaire) that he was aware of the changing lighting conditions during the duration of the experiment.

Subjects: Fifty-eight undergraduates in an introductory psychology course at a University representing a broad cross-section of student interests and backgrounds and sex took part in the experiment.

Design: In order to hold teacher characteristics and subject matter constant in this study, four classes of a single teaching assistant were used. In the design represented, each class was compared against itself under different lighting conditions in the subsequent or preceding week(thus avoiding the problem of interclass differences). The balancing of conditions effectively reduces the problem of order and serial position effects (e.g., fatique, practice) in the experimental paradigm.

According to the design, data were gathered during each seminar(with videotapes) and after each seminar (with questionnaires). The balanced pattern was extended from four weeks to eight for the purpose of increasing the amount of data gathered under the respective conditions and thus increasing the power of the statistical procedures employed.

Procedure: Three camera were mounted in the upper middle of the four classroom walls. While students generally felt that "Bib Brother was watching them" when they first entered the room, the cameras lost their more obvious obtrusiveness within a short while, and as evidenced by the videotapes, the great majority of students adapted to them by the second week.

The cameras were remotely operated by a technician in the control room who had television receivers to monitor the activity in the classroom.

Measures: A post seminar Questionnaire consisted of twenty bi-polar scales on which each subject was to judge his reactions to the class, the quality of the seminar and the atmosphere of the room. The items used a five point scale ranging from one identifiable end of a dimension to another, in a form somewhat similar to the semantic differential.

An additional open response item was added primarily for the purpose of giving subjects a feeling of freedom of expression on the questionnaire; it was also used as a source of data where appropriate.

Classroom interaction was analyzed by an observational system for coding spontaneous verbal communication, useful in this case for describing the patterns of communication occurring under different light sources. To accomplish this kind of observation it was necessary to select videotaped behavior patterns which could be identified and categorized for tabulation and graphic presentation. A system of interaction analysis based upon the methods devised to fit the needs of this specific study. Categories of student and teacher behavior were developed which would allow for quantification of original and digressive material, and positive and negative effect in the communication. A form was designed for recording the frequency of various types of communications. Using maps of the room the observers tracked the number and directional of verbal exchanges between subjects, and the overall pattern of interaction. This resulted in measures of amount of interaction, patterns of communication, and amount of non-teacher directed interaction.

Results: The results show quite clearly that there was no differential effect in self-reported attitudes to the respective lighting conditions. Only one variable, the cool-warm dimension, approaches any statistical significance, and the fact that it stands alone suggests that it probably represents the influence of some other chance factors.

Post-Experiment Appraisal of Conditions: At the end of the experiment, the investigator returned for the purpose of debriefing the subjects. This included revelation of the experimental conditions, explanation of the purpose of the research, description of discussion patterns of the experiment, however, and before the differences in the lights were discussed, students in each class asked to judge the respective lights on twenty dimensions.

Results: The results indicate that Vita-Lite was characterized by appearance as being brighter, stronger, more exciting, lively and stimulating as well as clearer and more pure. In contrast, the cool-white light was perceived as being warmer, softer, quieter and more pleasing, restful and unobtrusive than Vita-Lite. Vita-Lite was described as being more distracting and irritating while cool-white was considered more boring.

It is interesting to note that while colors were seen as more vibrant, and complexion more natural, under Vita-Lite, the actual light of cool-light was described as more natural. Given the spectral distribution of Vita-Lite as being similar to that of natural sunlight, one would have predicted just the opposite result. The explanation probably lies, however in the fact that cool-white is the standard light for classroom setting, and therefor, the Vita-Lite would seem less natural in the sense that it was more unusual for the particular environmental setting. The fact that Vita-Lite was described as closer and more pure suggest that it is indeed perceived as having "natural" qualities. Additional comments implying that the cool-white was more restful but also dull and that Vita-Lite was more stimulating but harsher.

Summary: The overall suggestion of these results is that while there is a negligible effect on mood, classroom performance, and classroom interaction from the lighting conditions, there is a clear difference in the qualitative characteristics of the conditions when direct observations and appraisals are made.

SLIDES

1. Exterior view of test site location at Dixon.	2. Interior view of classroom with green panels installed.	3. Same as Slide 2.	4. Green panels with track fixtures installed and operating.
5. Same as Slide 4.	6. Red panels installed.	7. Same as Slide 6.	8. Red panels installed with track fixtures operating.
9. Red panels installed with curtain in place.	10. Green panels installed with curtain in place.		